AFBMD Activities in Space Jun 60

SATELLITE
systems

DISCOVERER
SAMOS
MIDAS
COMMUNICATIONS SATELLITE

D i s c o v e r e r

The DISCOVERER Program consists of the design, development and flight testing of 33 two-stage vehicles, using the THOR IRBM as the first stage booster and the AGENA as the second stage, satellite vehicle. The program was established early in 1958 under direction of the Advanced Research Project's Agency, with technical management assigned to AFBMD. On 14 November 1959, program responsibility was transferred from ARPA to the Air Force by the Secretary of Defense. Prime contractor for the program is Lockheed Missile and Space Division. The DISCOVERER Program will perform space research in support of the advanced military reconnaissance satellite programs.

PROGRAM OBJECTIVES

(a) Flight test of the satellite vehicle airframe, propulsion, guidance and control systems, auxiliary power supply, and telemetry, tracking and command equipment.

(b) Attaining satellite stabilization in orbit.

(c) Obtaining satellite internal thermal environment data.

(d) Testing of techniques for recovery of a capsule ejected from the orbiting satellite.

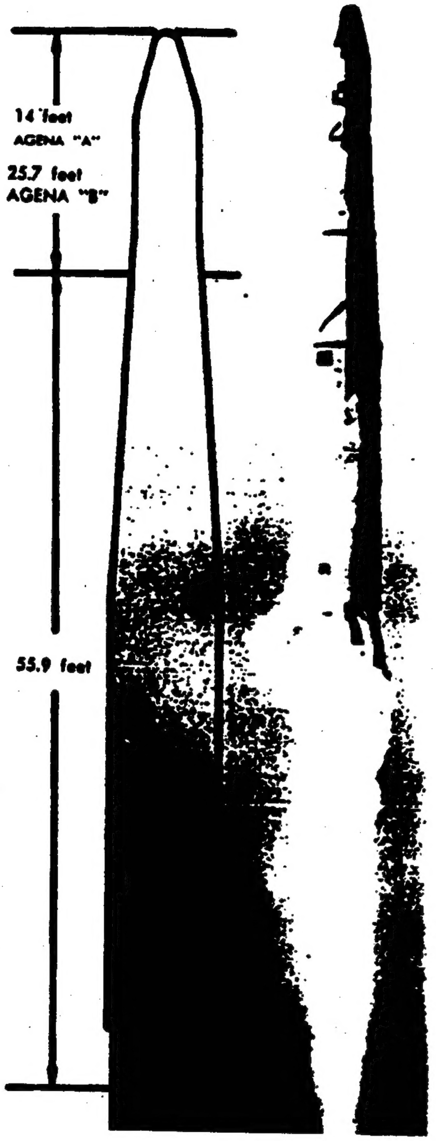
(e) Testing of ground support equipment and development of personnel proficiency.

(f) Conducting bio-medical experiments with mice and small primates, including injection into orbit, re-entry and recovery.

PROGRAM SUMMARY

Early launches confirmed vehicle flight and satellite orbit capabilities, developed system reliability, and established ground support, tracking and data acquisition requirements. Later in the program, biomedical and advanced engineering payloads will be flight tested to obtain support data for more advanced space systems programs. DISCOVERER vehicles are launched from Vandenberg Air Force Base, with overall operational control exercised by the Satellite Test Center, Palo Alto, California.

Tracking and command functions are performed by the stations listed in the Table on page A-4. A history of DISCOVERER flight to date is given on page A-5.



SECOND STAGE	AGENA "A"	AGENA "B"	
Weight—			
Inert	1,262	1,328	1,346
Payload equipment	497	887	915
Orbital	1,759	2,215	2,216
Impulse propellants	6,525	12,950	12,950
Other	378	511	511
TOTAL WEIGHT	8,662	15,676	15,722
Engine Model	YLR81-Ba-5	XLR81-Ba-7	XLR81-Ba-9
Thrust-lbs., vac.	15,600	15,600	16,000
Spec. Imp.-sec., vac.	277	277	290
Burn time-sec.	120	240	240

THOR BOOSTER	DM-18	DM-21
Weight—Dry	6,950	6,500
Fuel	33,700	33,700
Oxidizer (LOX)	68,200	68,200
GROSS WEIGHT (lbs.)	108,850	108,400
Engine	MB-3 Block 1	MB-3 Block 2
Thrust, lbs. (S.L.)	152,000	167,000
Spec. Imp., sec. (S.L.)	247.8	248.3
Burn Time, sec.	163	148

Telemetry ships are positioned as required by the specific mission of each flight. Figures 2 and 3 show a typical launch trajectory from Vandenberg Air Force Base, and figure 3 shows schematically a typical orbit. An additional objective of this program is the development of a controlled re-entry and recovery capability for the payload capsule (Figure 4). An impact area has been established near the Hawaiian Islands, and a recovery force activated. Techniques have been developed for aerial recovery by C-119 aircraft and for sea recovery by Navy surface vessels. The recovery phase of the program has provided advances in re-entry vehicle technology. This information will be used in support of more advanced projects, including the return of a manned satellite from orbit.

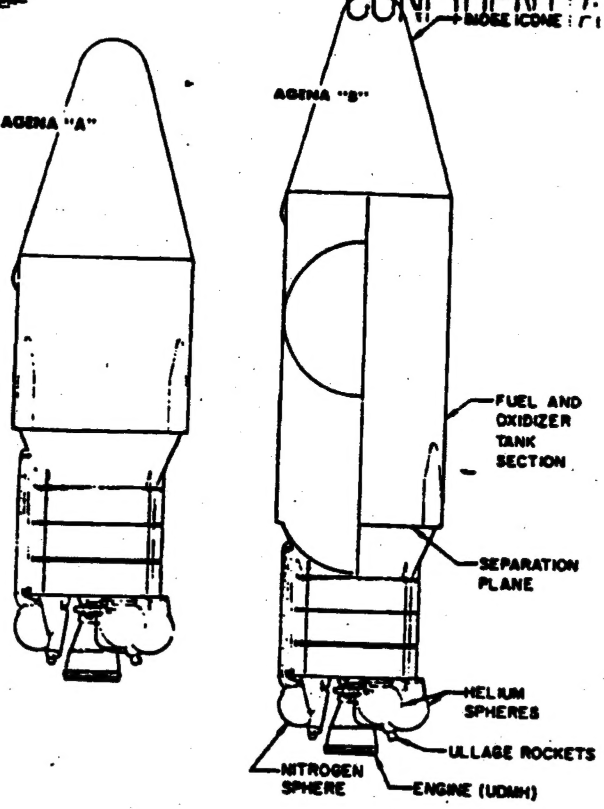
FLIGHT VEHICLE

The three versions of flight test vehicles used in the DISCOVERER Program are defined in the launch schedule shown on page A-5. Specifications for the two THOR configurations and three AGENA configurations used are given on page A-1.

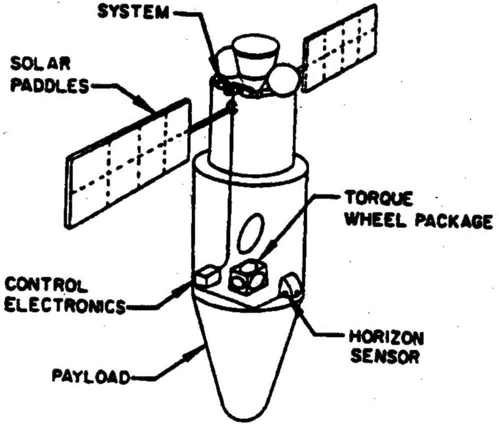
AGENA VEHICLE DEVELOPMENT

The AGENA vehicle was originally designed by the Air Force as the basic satellite vehicle for Advanced Military Reconnaissance Satellite Systems Programs. Basic design was based on use of the ATLAS ICBM as the first stage. ATLAS trajectory characteristics and the stringent eccentricity requirements of the advanced programs led to the selection of a guidance system suited to achieving orbital injection in a horizontal attitude. As a result, an optical inertial system was developed for vehicle guidance and a gas jet system for orbital attitude control. An urgent need for attaining higher altitude orbits resulted in development of the AGENA "B" versions. The YLR81 Ba-5 version of the LR81-Ba-3 engine (Bell Hustler engine developed for B-58 aircraft) is used on AGENA "A" vehicles. The YLR81-Ba-5 version of this engine was developed to provide increased performance through the use of unsymmetrical di-methyl hydrazine (UDMH) fuel instead of JP-4.

Early AGENA "B" vehicles will use the YLR81-Ba-7 version of this engine. The majority of AGENA "B" vehicles will use the XLR81-Ba-9 engine incorporating a nozzle expansion ratio of 45:1, and providing a further increase in performance capability including engine restart and extended burn-capability.



SAMOS and MIDAS
AGENA VEHICLE

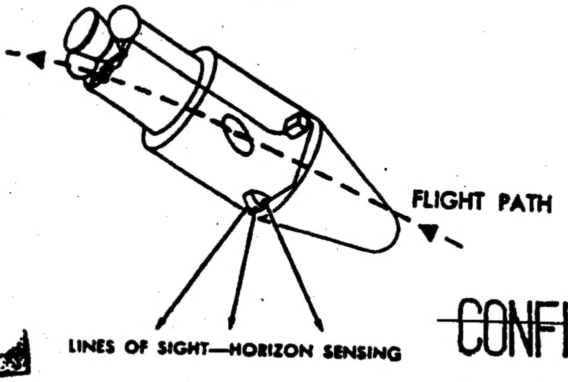


DISCOVERER/AGENA

PERFORMANCE CAPABILITIES

ALTITUDE
200–20,000 MILES

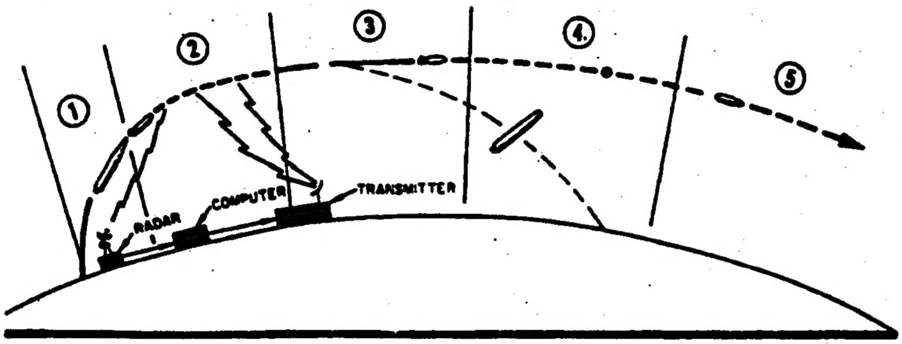
ATTITUDE
ROLL – 0.1 DEGREE
PITCH – 0.1 DEGREE
YAW – 1 DEGREE



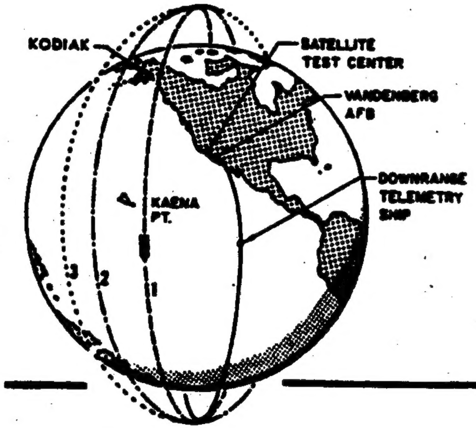
~~ENTIAL~~
OSE CONFIDENTIAL

~~SECRET~~

Powered Flight Trajectory

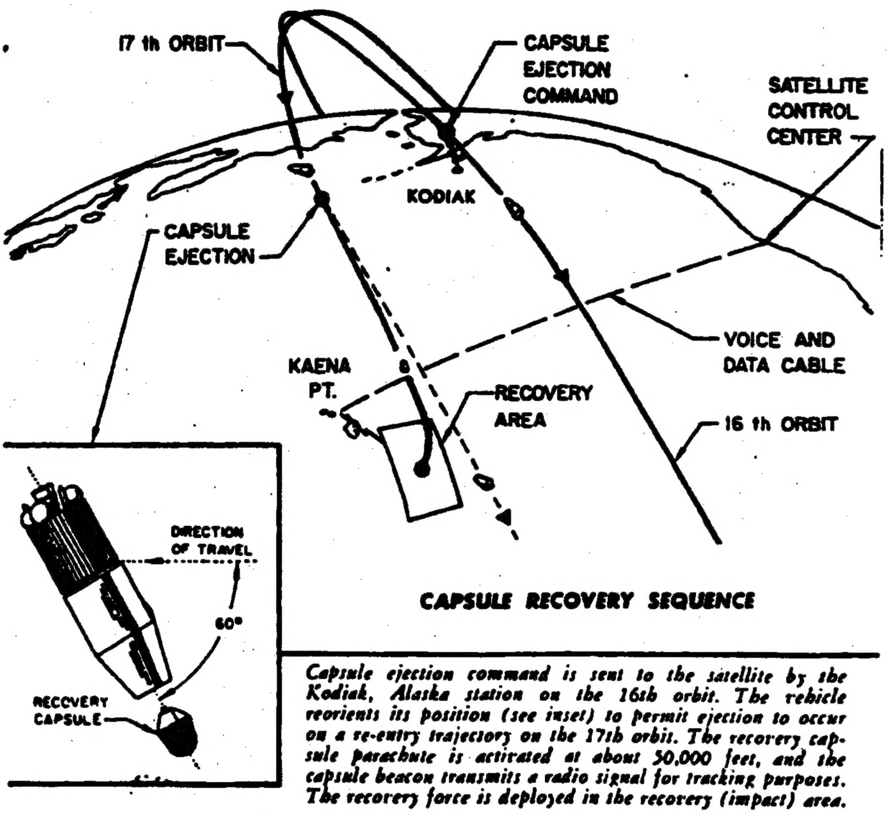


1. **First Stage Powered Flight**—2.5 minutes duration, 78 n.m. downrange, guided by programmed auto pilot.
2. **Coast Period**—2.4 minutes duration, to 380 n.m. downrange; altitude controlled by inertial reference package, horizon scanner, gas reaction jets. Receives AGENA time to fire and velocity to be gained commands.
3. **Second Stage Powered Flight**—2 minutes duration, to 770 n.m. downrange. Guided and controlled by inertial reference package, horizon scanner, gas reaction jets (roll) gimballing engine, yaw and pitch accelerometer—integrated.
4. **Vehicle Reorients to Nose Aft**—2 minutes duration, to 2,000 n.m. downrange. Guided and attitude controlled by inertial reference package, horizon scanner and gas reaction jets.
5. **In-Orbit**—Controlled (same as 4).



Orbital Trajectory

Schematic presentation of orbital trajectory following launch from Vandenberg Air Force Base. Functions performed by each station and a listing of equipment used by each station, is given on page A-4.



RECOVERY CAPABILITY

This objective was added to the program after the first launch achieved vehicle flight and orbit objectives successfully. It includes the orientation of the satellite vehicle to permit a recoverable capsule to be ejected from the nose section of the AGENA vehicle. Ejection is programmed to occur on command on the 17th orbit, for capsule impact within the predetermined recovery area south of Hawaii. Aircraft and surface vessels are deployed within the area as a recovery force.

CAPSULE RECOVERY SEQUENCE

Capsule ejection command is sent to the satellite by the Kodiak, Alaska station on the 16th orbit. The vehicle reorients its position (see inset) to permit ejection to occur on a re-entry trajectory on the 17th orbit. The recovery capsule parachute is activated at about 50,000 feet, and the capsule beacon transmits a radio signal for tracking purposes. The recovery force is deployed in the recovery (impact) area.

—FUEL AND
OXIDIZER
TANK
SECTION

—SEPARATION
PLANE

-IELIUM
SPHERES

.LAGE ROCKETS

E (UDMH)

urgent
lted in
YLR81
Hustler
ed on
of this
:rform-
methyl

1-Ba-7
A "B"
›rating
ding a
luding

:GHT PATH

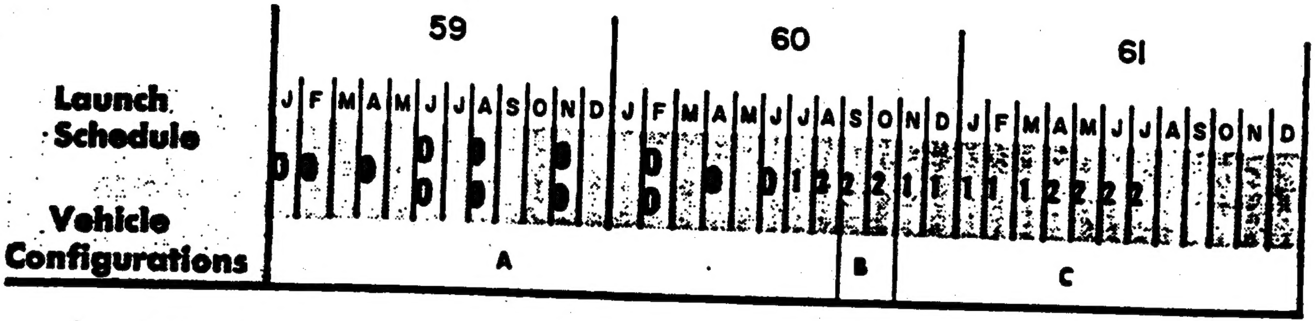
~~CONFIDE~~

Facility	Equipment	Flight Function
Satellite Test Center	A	Over-all control, convert tracking stations data to obtain a predicted orbit and generate subsequent ephemerides issue acquisition data to tracking stations for subsequent passes, predict recovery area.
Vandenberg AFB	BCDEFGHIJK	Launch, ascent and orbital tracking, telemetry reception, trajectory measurements including time to ignite second stage.
Point Mugu	BCDEFGHIJKL	Ascent tracking and telemetry data reception, transmits command to ignite and shut down AGENA (via guidance computer).
Telemetry Ship (Pvt. Joe E. Mann)	DF	Final stage ascent tracking and telemetry data reception.
Annette Island, Alaska (tracking station)		Activity at this station terminated 1 December 1959 due to fund limitations.
Kodiak, Alaska (tracking station)	BDEFGHIJK	Orbital tracking and telemetry data reception, including first pass acquisition, recovery capsule ejection and impact prediction.
Kaena Point, Oahu, Hawaii (tracking station)	BCDEFGHIJK	Orbital tracking and telemetry data reception.
Hickam AFB Oahu, Hawaii		Over-all direction of capsule recovery operations.

*Equipment

a. 2 UNIVAC 1103-A digital computers
b. VERLORT (Modified Mod II) radar
c. TLM-18 self-tracking telemetering antenna
d. Tri-helix antenna
e. Doppler range detection equipment
f Telemetry tape recording equipment
g Telemetry decommutators for real time data presentation
h. Plot boards for radar and TLM-18 tracking data
i. Conversion equipment for teletype transmission of radar. TLM-18 and doppler tracking data in binary format
j. Acquisition programmer for pre-acquisition direction of antennas
k. Ground command to satellite transmission equipment
l. Guidance computer

GROUND SUPPORT FACILITIES



A. THOR—DM-18 / AGENA "A"

B. THOR—DM-21 MB-3 Block 1 / AGENA "B" XLR81-Ba-7

C. THOR—DM-21 MB-3 Block 2 / AGENA "B" XLR81-Ba-9

○ Attained orbit successfully.

● Failed to attain orbit.

Flight History

DISCOVERER No.	AGENA No.	THOR No.	Flight Date	Remarks
0	1019	160	21 January	*AGENA destroyed by malfunction on pad. THOR refurbished for use on flight XII.*
I	1022	163	28 Feb 1959	*Attained orbit successfully. Telemetry received for 514 seconds after lift-off.*
II	1018	170	13 April	*Attained orbit successfully. Recovery capsule ejected on 17th orbit was not recovered. All objectives except recovery successfully achieved.*
III	1020	174	3 June	*Launch, ascent, separation, coast and orbital boost successful. Failed to achieve orbit because of low performance of satellite engine.*
IV	1023	179	25 June	*Same as DISCOVERER III.*
V	1029	192	13 August	*All objectives successfully achieved except capsule recovery after ejection on 17th orbit.*
VI	1028	200	19 August	*Same as DISCOVERER V.*
VII	1051	206	7 November	*Attained orbit successfully. Lack of 400-cycle power prevented stabilization on orbit and recovery.*
VIII	1050	212	20 November	*Attained orbit successfully. Malfunction prevented AGENA engine shutdown at desired orbital velocity. Recovery capsule ejected but not recovered.*
IX	1052	218	4 February	*THOR shut down prematurely. Umbilical cord mast did not retract. Quick disconnect failed, causing loss of helium pressure.*
X	1054	223	19 February	*THOR destroyed at T plus 56 sec. by Range Safety Officer.*
XI	1055	234	15 April	*Attained orbit successfully. Recovery capsule ejected on 17th orbit was not recovered. All objectives except recovery successfully achieved.*
XII	1053	160	29 June	*Launch, ascent, separation, coast and orbital stage ignition were successful. Failed to achieve orbit because of AGENA attitude during orbital stage boost.*

MONTHLY PROGRESS—DISCOVERER Program

Flight Test Progress

- DISCOVERER XII was launched at 2300, GMT, on 29 June from Pad 4 of Complex 75-3, Vandenberg Air Force Base. The countdown proceeded satisfactorily with minor technical holds because of ground support equipment problems. The major hold was caused by weather. The launch, first stage trajectory, engine cutoff, and separation were normal. AGENA engine ignition, thrust and engine cutoff were also normal. However, the satellite failed to achieve orbit. Telemetry data indicate that the AGENA vehicle was in a pitch down attitude during engine operation causing the vehicle to re-enter the atmosphere. Subsequent investigation has isolated the cause of the improper pitch attitude to the horizon scanner. A thorough examination of the horizon scanner operation and checkout is being conducted to determine the reason for malfunction and to correct the condition prior to the launch of DISCOVERER XIII.

- DISCOVERER XII carried a diagnostic payload in addition to the normal recovery equipment. The payload contained instrumentation to determine capsule environment and the functioning of separation and recovery sequence events. A five chanel telemetry system was installed to transmit the data obtained to the ground stations. To assure receipt of all data, a tape recorder was provided to record the real time events and capsule performance during the telemetry "blackout" period which occurs when the capsule re-enters the atmosphere. After a two-minute time delay, this stored data would be transmitted to the ground stations. The high speed of re-entry induces ionization over the skin of the capsule which effectively blocks telemetry transmission. An S-band transponder was also provided to aid in tracking the capsule from ejection through recovery. DISCOVERER XIII will carry an identical diagnostic capsule.

Technical Progress

Second Stage Vehicles

- One AGENA "B" vehicle (XLR-81Ba-7 engine) is in storage following Air Force acceptance. Three other vehicles with XLR-81Ba-7 engines have completed hot firing tests at Santa Cruz Test Base and have been returned to the systems test area for rework and a second system check prior to Air Force acceptance. The first two AGENA "B" vehicles using the XLR-81Ba-9 engine are ready for hot firing system testing at Santa Cruz Test Base.

- Evaluation and testing of nozzle coatings in an effort to reduce XLR-81Ba-9 engine throat erosion continued during the report period. The test results using a modified fuel injector have been encouraging. Tests of this injector will continue.

- Testing of the XLR-81Ba-9 engine (with 45:1 area ratio nozzle) continued at Arnold Engineering Development Center. An engine start and restart firing series covering a temperature range of 120 to −55 degrees F has been completed. The engine is mounted in a modified test stand which permits engine gimballing.

Recovery System Component Test Program

- Extensive examination of the results of DISCOVERER flight I through XI has indicated the possibility of tumbling and/or precession of the capsule upon separation from the AGENA vehicle because one or more of the spin/de-spin rockets failed to fire properly. To correct this condition a "cold gas" spin/de-spin system was incorporated into the DISCOVERER XII payload. The "cold gas" system contains two separate subsystems each supplying a maximum of 195 pounds thrust with a firing duration of 0.8 seconds. Each system contains a gas bottle (containing a nitrogen and freon gas mixture), a manifold, a squib operated valve, and exhaust jets.

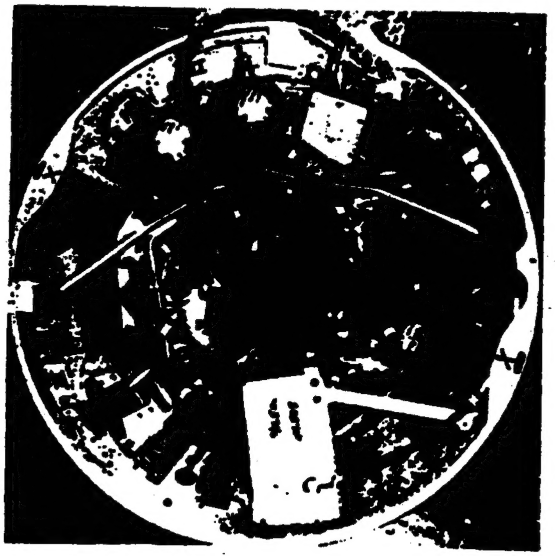


Figure 1. The thrust cone for the diagnostic payload showing the "cold gas" spin/de-spin systems. The gas spheres, squib operated valves, and manifolds for each system are shown in the top of the photo. The exhaust jets are mounted on the outside of the cone. The thrust cone separates from the payload prior to parachute deployment.

- Drop testing of the DISCOVERER capsules continued throughout the report period at Holloman Air Force Base, New Mexico. Originally scheduled for nine drops, the test series has been extended to permit field testing of the capsule parachute system and testing of retrofiring system. Solid propellant rocket spin/de-spin systems tests were conducted on 24 May. "Cold gas" systems tests were conducted on 23 June. The parachute system tests started prior to the solid propellant rocket test and are still in progress.

- For each of the drop tests, the capsule is carried to 100,000 feet altitude. On command from the ground, the capsule is released from a fairing which simulates the AGENA vehicle. During the retrofiring system drop, the ejection programmer within the capsule fires the spin system, the retro rocket, and the de-spin system in the normal ejection sequence. Parachute deployment is also controlled by the ejection programmer. These capsules are fully instrumented to monitor capsule performance and contain telemetry equipment to transmit the data obtained. In the parachute deployment tests the Mach and dynamic loading conditions encountered in actual recoveries are experienced.

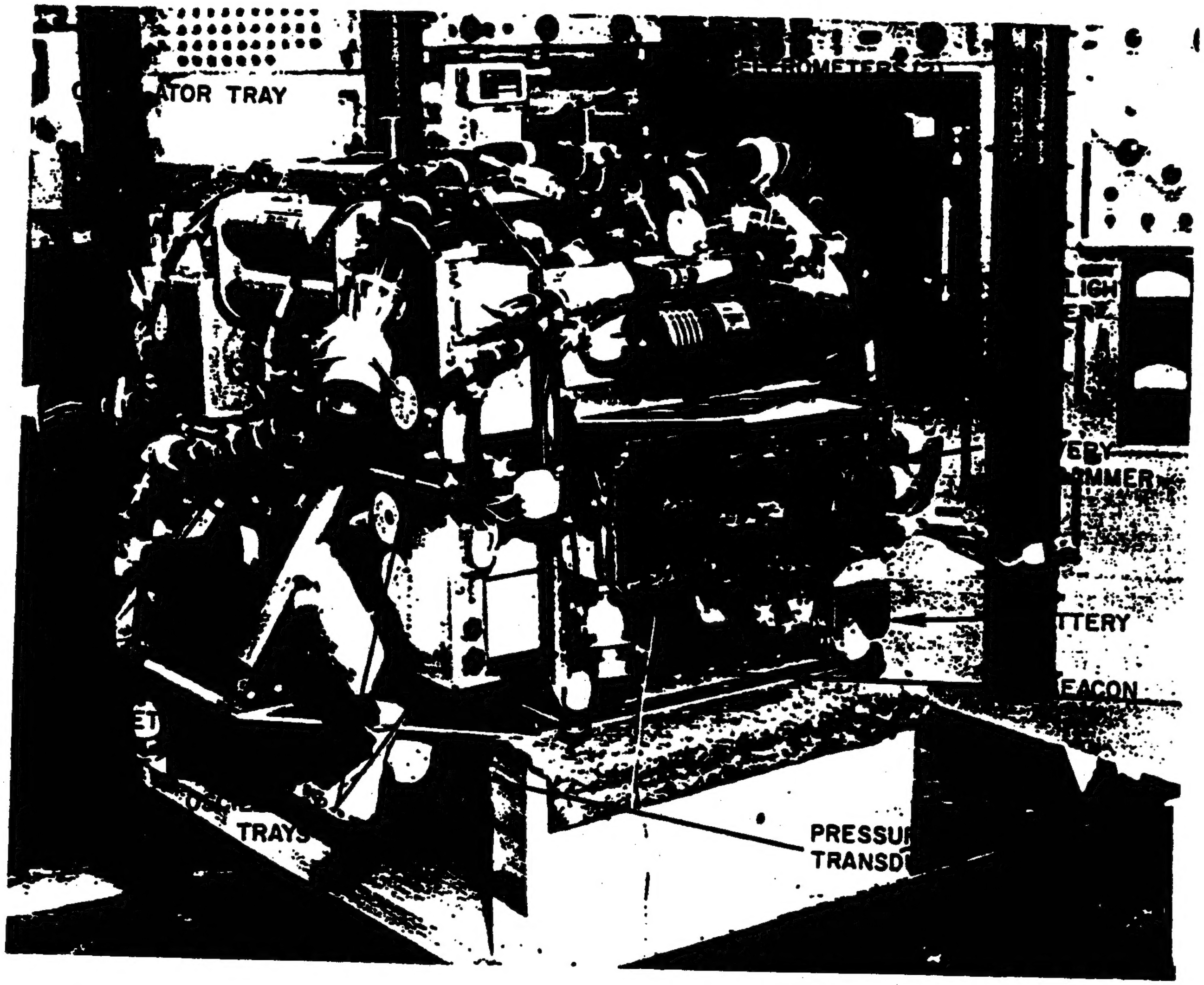
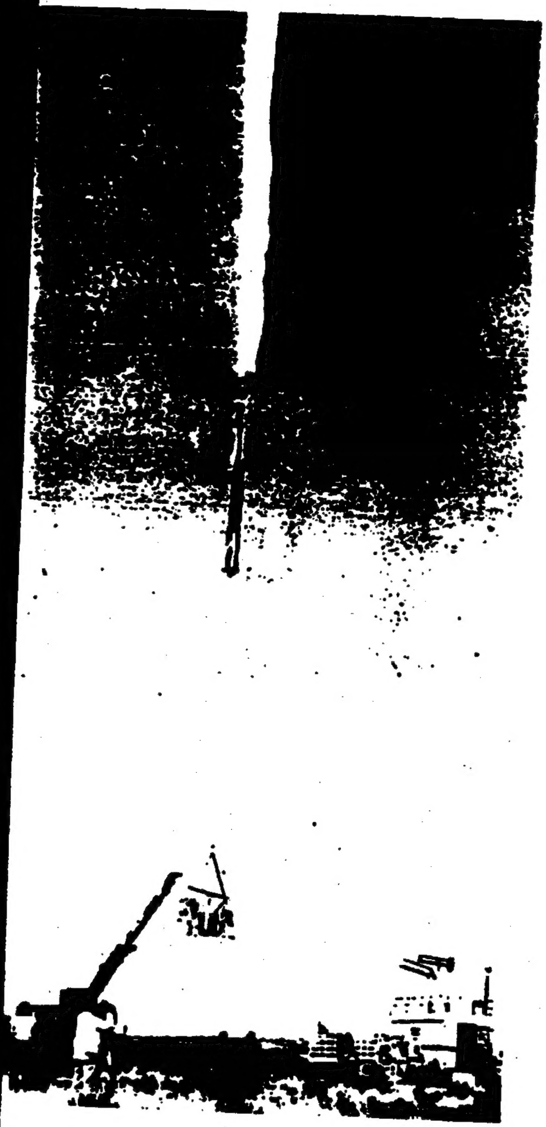


Figure 2. DISCOVERER diagnostic flight payload shown during system tests prior to shipment to Vandenberg Air Force Base. The equipment contained in this payload monitors the performance of the ejection and recovery system components and telemeters this data to the ground stations.



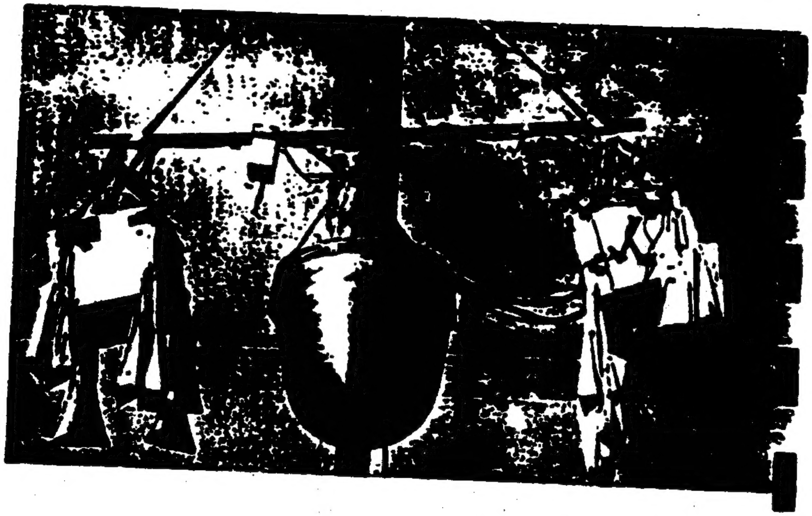
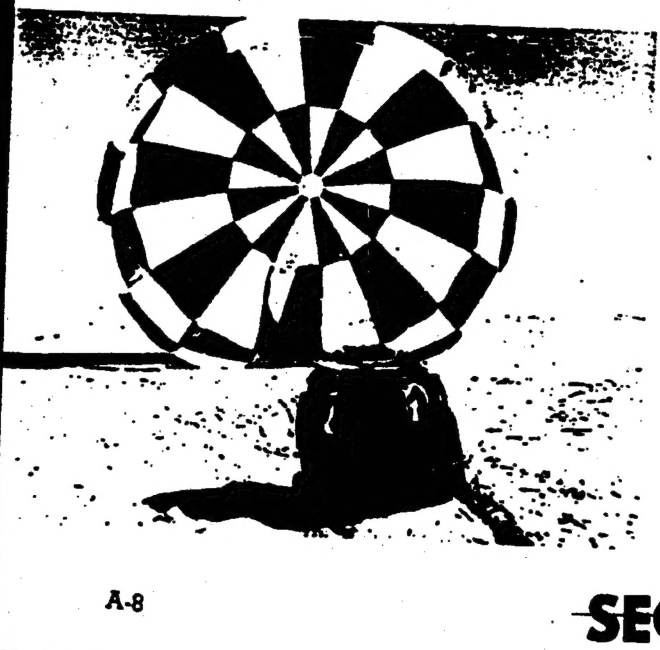


Figure 3. Test capsule (left) suspended from the balloon that will carry it to 100,000 feet altitude. Closeup (above) of test capsule and telemetry equipment which provides flight data and through which the release command is received. The ablative shield which protects the capsule from the heat generated during high speed re-entry into the atmosphere is shown. The external surface of the shield peels off under the intense heat of friction, thus dissipating the heat and protecting the capsule. The capsule and parachute are contained within this shield. Aerial view (right) of the capsule during descent over New Mexico. The parachute deployed at approximately 55,000 feet altitude. Capsule immediately after impact (lower right). Closeup of the capsule and parachute (lower left). An impact at sea would cause little damage to the capsule structure.



Biomedical Capsules

- The Advanced Biomedical Capsule Study was completed on 17 June. This study indicated the feasibility of developing a capsule capable of maintaining a chimpanzee in orbit for two days. The capsule would be integrated with the SAMOS recovery vehicle. A final report, preliminary drawings and a full-scale mockup have been prepared as part of the study.

Facilities

- A van-type telemetry readout and recording installation has been established on Christmas Island. This installation will provide monitoring and recording facilities downrange from Hawaii. The equipment at this installation will monitor all orbital passes within the range of the station, record all telemetry data from the diagnostic payload and from the AGENA vehicle. During the recovery pass, this installation will extend the telemetry reception coverage south of the equator. An additional ship and five telemetry equipped aircraft will be dispersed between Hawaii and Christmas Island to complete the telemetry coverage south of Hawaii.

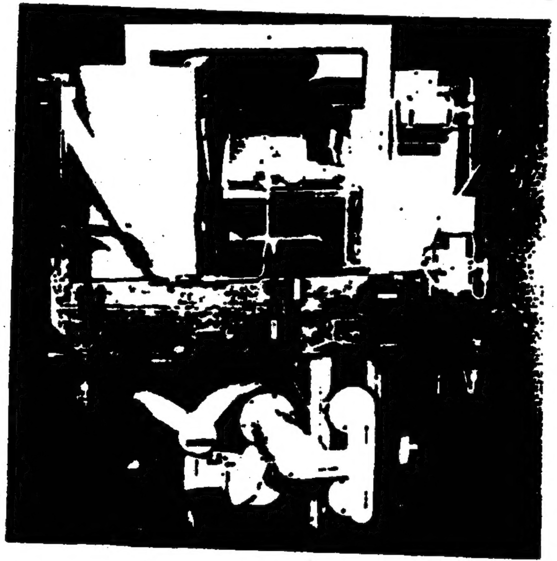
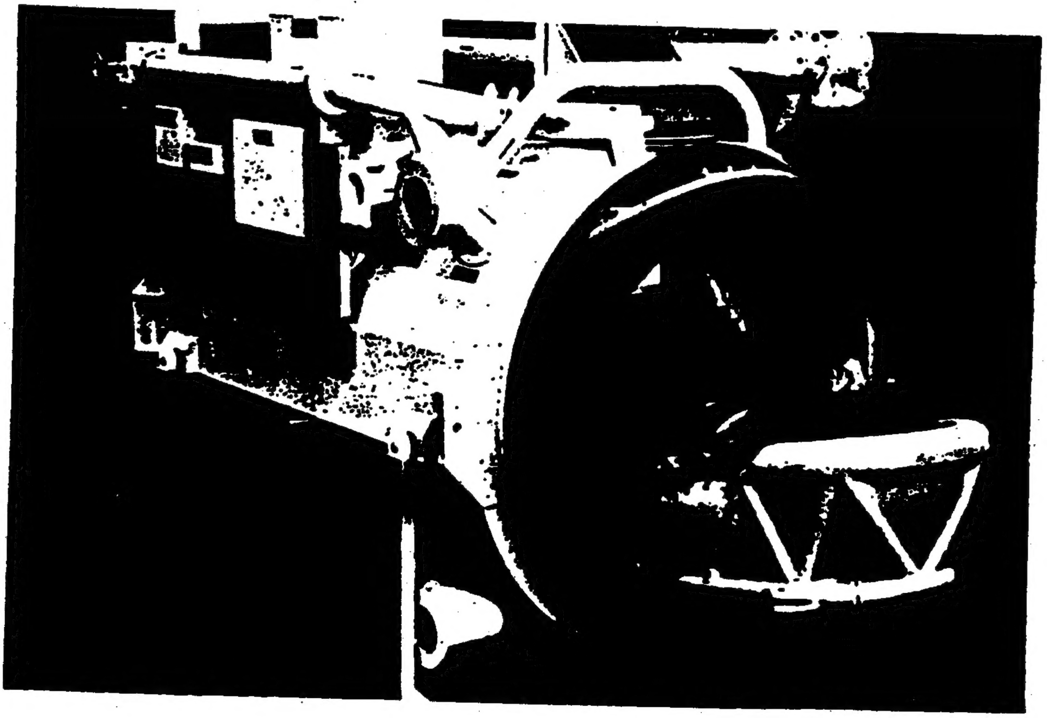


Figure 4. The Advanced Biomedical Capsule mockup (below) with a model of the 30-pound chimpanzee and the seat partially installed. Specimen-recording and telemetry equipment are mounted on the top of the capsule. Forward end of the mockup (left) showing oxygen spheres, blowers, and coolant equipment. This mockup was constructed as part of the Advanced Biomedical Capsule Study.

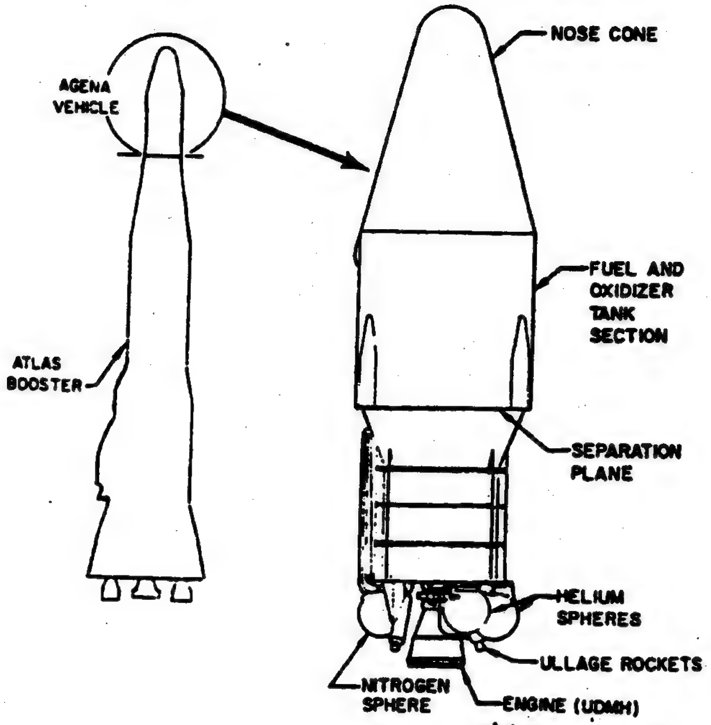


BOOSTER—ATLAS ICBM	
Weight—Wet	15,100
Fuel, RP-1	74,900
Oxidizer (LOX)	172,300
GROSS WEIGHT (lbs.)	262,300
Engine—MA-2	
Thrust (lbs. vac.) Boost	356,000
Sustainer	82,100
Spec. Imp. (sec. vac.) Boost	286
Sustainer	310

SECOND STAGE	AGENA "A"	AGENA "B"
Weight—		
Inert	1,508	1,695
Payload equipment	2,605	3,058
Orbital	4,113	4,753
Impulse Propellants	6,492	12,950
Fuel (UDMH)		
Oxidizer (IRFNA)		
Other	606	718
GROSS WEIGHT (lbs.)	11,211	18,421
Engine	YLR81-Ba-5	XLR81-Ba-9
Thrust, lbs. (vac.)	15,600	16,000
Spec. Imp., sec. (vac.)	277	290
Burn Time, sec.	120	240

Figure 1.

Artists' concept of SAMOS satellite. Line drawing of complete flight vehicle (right) and detailed view of basic AGENA upper stage (left).



PROGRAM HISTORY

The SAMOS Program was included in Weapon System 117L when WS 117L was transferred to the Advanced Research Projects Agency early in 1958. ARPA separated WS 117L into the DISCOVERER, SAMOS and MIDAS programs with the SAMOS objectives based on a visual and ferret reconnaissance system. On 17 November 1959 responsibility for this program was transferred from ARPA to the Air Force by the Secretary of Defense.

PROGRAM MISSION

The primary mission of the SAMOS advanced reconnaissance system is to provide visual and electronic coverage of the USSR and its allied nations. Efforts include development of hardware to permit:

a. Determination of characteristics of enemy electronic emissions.

b. Verification of known targets, detection of unknown targets.

c. Location and evaluation of defenses.

d. Evaluation of military and industrial strength.

e. Assessment of high-yield weapons damage.

f. Reconnoitering of troop movements.

g. Location of naval forces throughout the world.

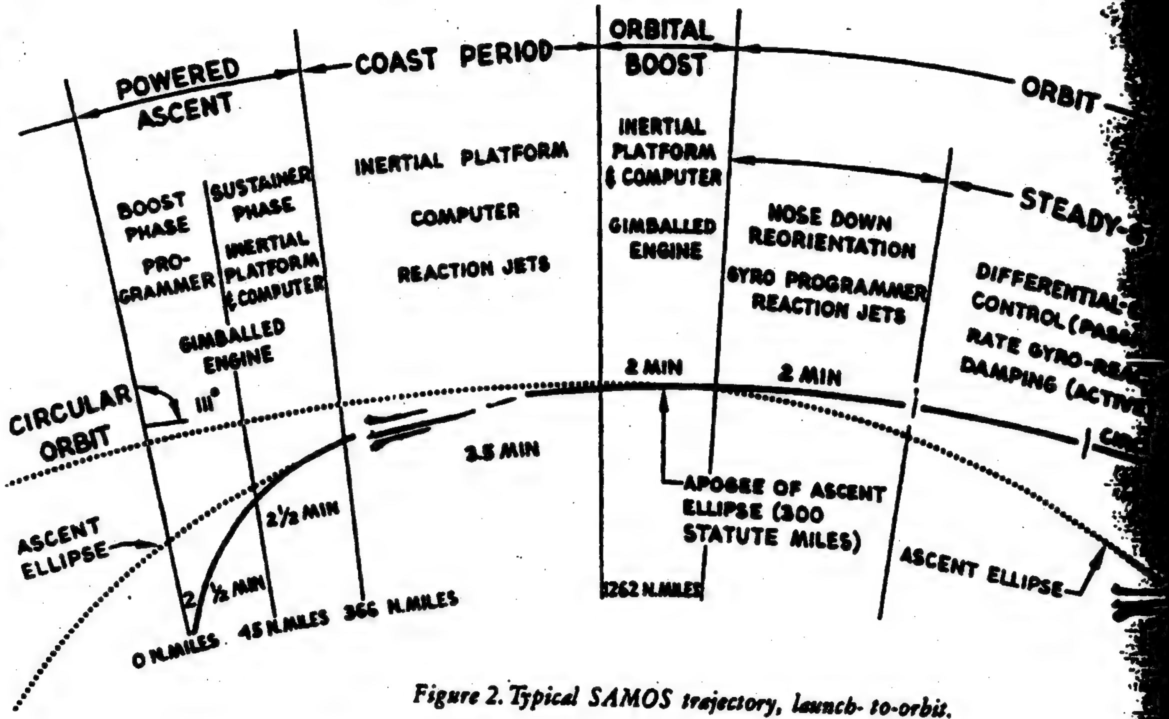


Figure 2. Typical SAMOS trajectory, launch- to-orbit.

Ferret Reconnaissance...

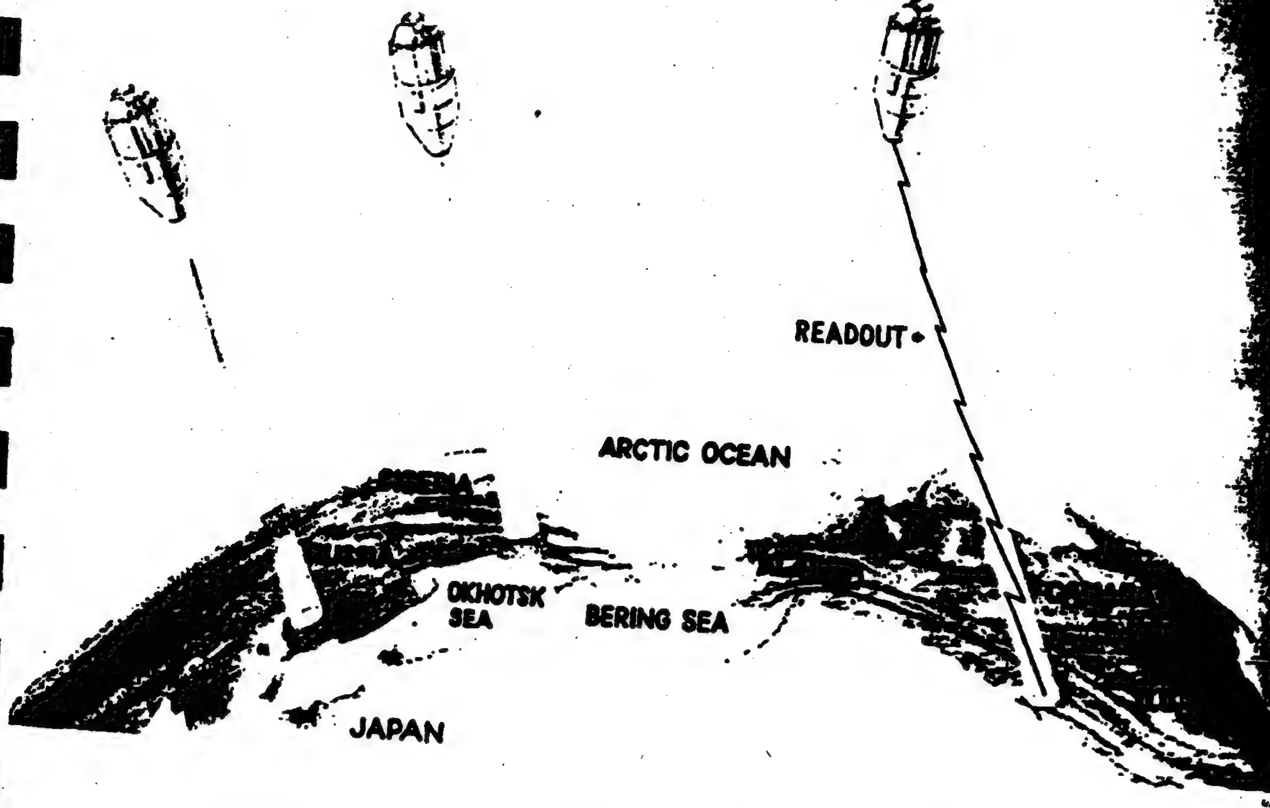


Figure 4. The Ferret reconnaissance system will gather data from electronic emissions over areas of interest.

SECRET

~~CONFIDENTIAL~~

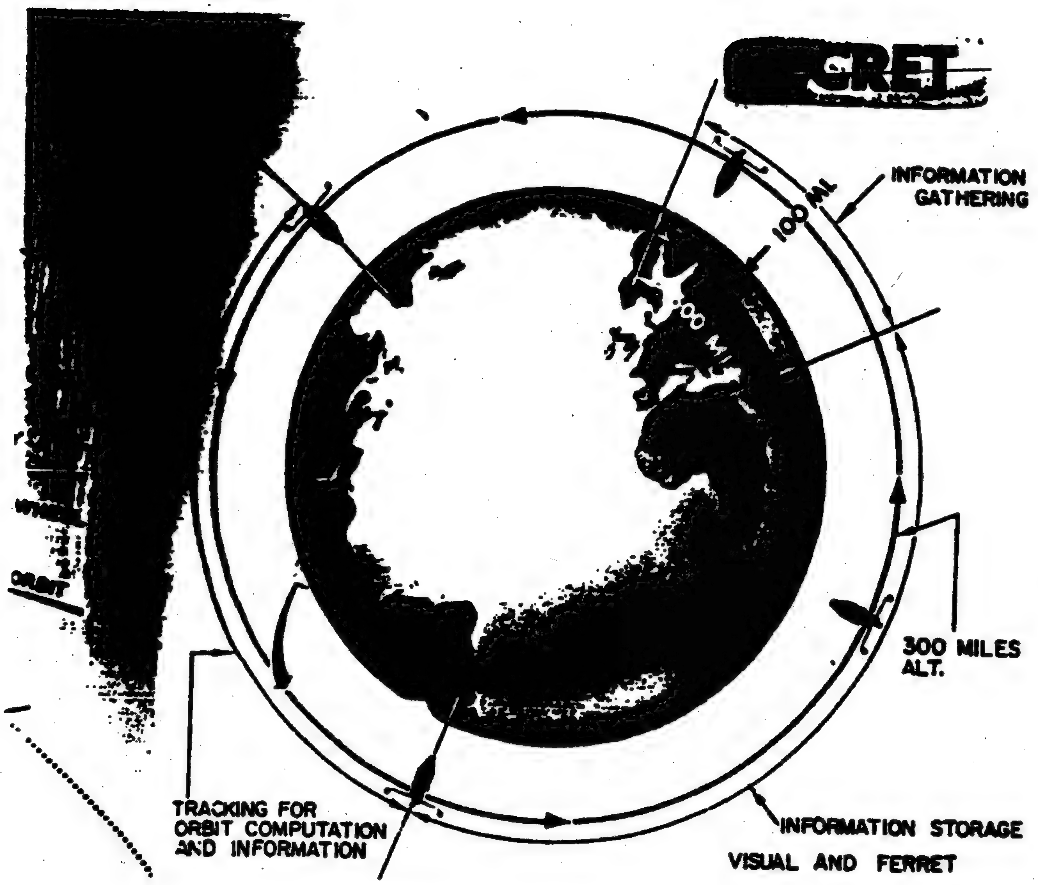


Figure 3.
Schematic of SAMOS system in operational orbit. When the satellite is over the area of interest the sensing equipment is turned on (Information gathering). When it leaves the area of interest the sensing equipment is turned off and the sensing data is processed (Information storage). When the vehicle comes within range of a ground receiving station, the data will be read-out upon command for processing and transmitted to using agencies. This process is continuously repeated during the useful lifetime of the vehicle.

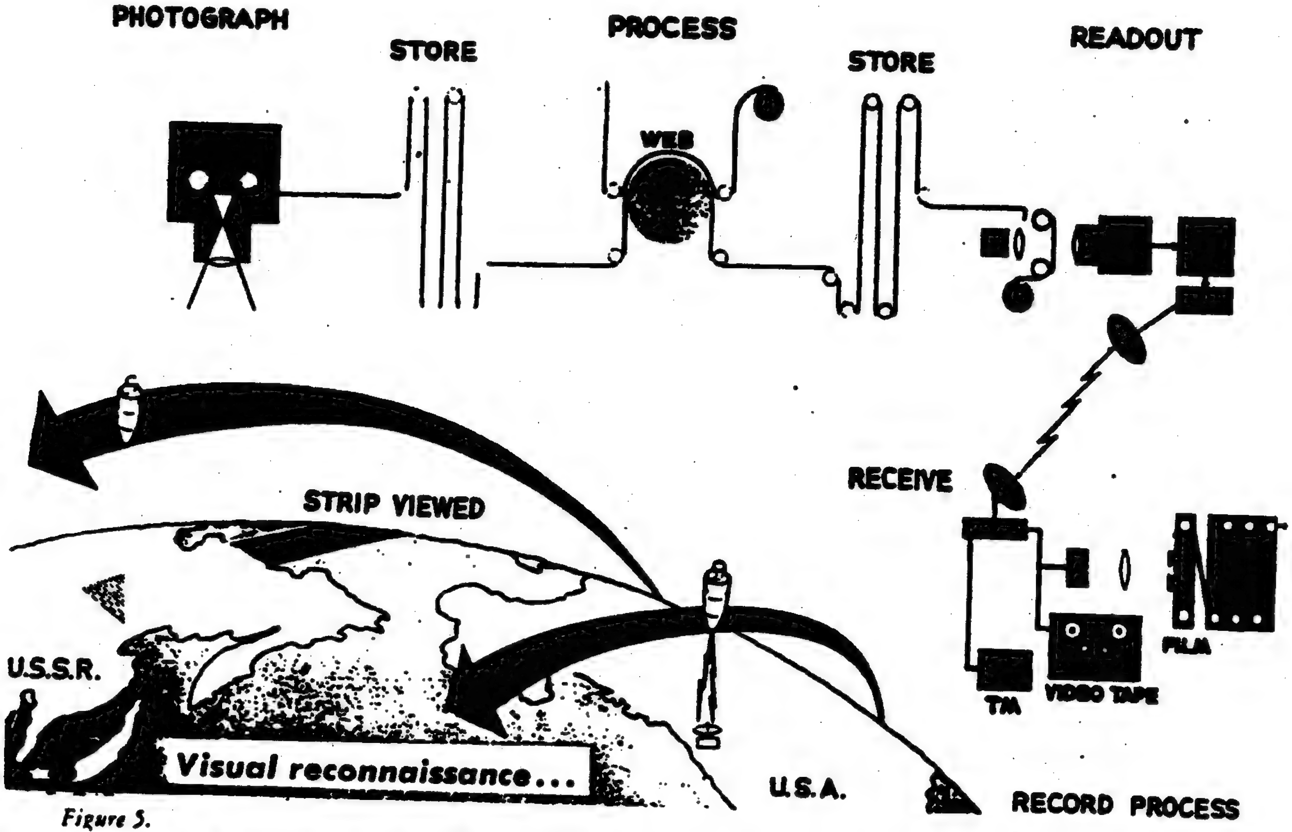


Figure 5.
The initial visual reconnaissance program will use conventional photo techniques with automatic film processing and TV-type electronic image readout to ground stations thru a data link. Ground electronics will reconvert the signal into photo image form, with a capability of resolving objects 20 feet in length.

SECRET

~~CONFIDENTIAL~~

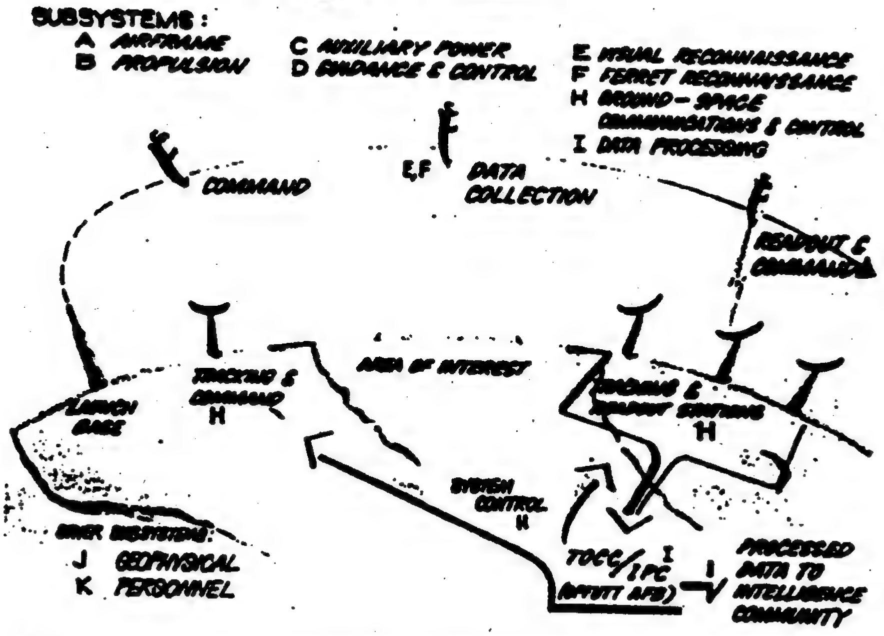


Figure 6. SAMOS concept, showing reception of commands and transmission of data between satellite and ground station; and subsystem functions (schematic).

For economical testing of components a dual-capability visual and ferret payload will be used during the early development phase. On later flights only a visual or ferret system payload will be carried. These payloads will be housed in the AGENA vehicle (Figure 1).

Data collected by the visual payloads will be electronically transmitted in the readout system and retrieved in the recovery system. Ferret data will be transmitted electronically. These systems are composed of the AGENA vehicle, ATLAS booster, launch facilities, tracking facilities, and a communications and data processing network. The recovery system will also include a re-entry capsule and a recovery force.

CONCEPT

ATLAS Series D missiles launched from VAFB will boost the AGENA vehicle into polar orbits. Injection into near-circular orbits (Figure 2) will be accomplished by the AGENA vehicle rocket engine. A self-contained guidance system using a horizon reference scanner will provide altitude stabilization. As the satellite travels in an orbit essentially fixed in space the earth rotates inside the orbit (Figure 3). Each successive orbit is displaced laterally approximately 23½ degrees at the equator, permitting one vehicle to observe the entire earth in a time period dependent upon the width of the area under surveillance. Early versions will have a useful life of approximately ten days. The readout systems will have a useful life of four months with a design objective in certain configurations of one year; recovery systems will have a useful life of fifteen to thirty days.

TECHNICAL DESCRIPTION

Visual Program—Three versions (E-1, E-2, and E-5) of visual payloads are being developed. The E-1 payload is a photo component test payload which is combined with the F-1 ferret payload. The E-2 photographic payload, under development by Eastman Kodak Company, includes a camera, film processor, and electronic readout equipment. The E-5 recoverable system designed by Lockheed will retain the exposed film and the 66-inch focal length camera developed by Itek Corporation.

Ferret Program—Ferret payloads are being developed on a progressively more advanced basis from R&D (F-1) to advanced systems (F-4). The F-2 all-digital, general coverage payload will use superheterodyne scanning receivers in conjunction with directional antennas, an analog to digital converter and tape recorders (for storage). A programmer will be used to control read-in over areas of interest and readout over tracking stations. The F-3 payload will use similar receivers with stop-scan capability and controllable antennas added. Recording of the actual signal intercepted (rather than the digital representation) will be possible with a bandwidth up to 6mc. A complex programmer will permit satellite search of a given area or frequency range.

	60											
	J	F	M	A	M	J	J	A	S	O	N	D
									1		1	
VEHICLE CONFIGURATIONS	ATLAS "D"/AGENA "A"											

	61											
	J	F	M	A	M	J	J	A	S	O	N	D
	1			1		1		1	1	1	1	2
VEHICLE CONFIGURATIONS	ATLAS "D"/AGENA "A"	ATLAS "D"/AGENA "B"										

	62											
	J	F	M	A	M	J	J	A	S	O	N	D
		1		2		1	2	2	1	1	2	2
VEHICLE CONFIGURATIONS	ATLAS "D"/AGENA "B"											

SAMOS Launch Schedule

MONTHLY PROGRESS—SAMOS Program

Technical Progress

Second Stage Vehicles

- System checks of the AGENA vehicle and the dual payload for the first SAMOS flight were completed satisfactorily on 1 June. The quality assurance inspection and weighting operations were completed prior to shipping the AGENA vehicle to Santa Cruz Test Base for captive hot firing tests. The vehicle was installed in the test stand, the payloads were delivered, and the systems tests which precede hot firings were accomplished. Captive hot firing tests were conducted on 30 June.

- Modification providing improvement in payload auxiliary real time command capability (through increased backup to the airborne communications equipment sequence programmer) are essentially complete for the second AGENA "A" vehicle. Lack of a UHF narrow band transmitter continued to hamper checkout. Subsystem testing is being accomplished with a prototype narrow band transmitter.

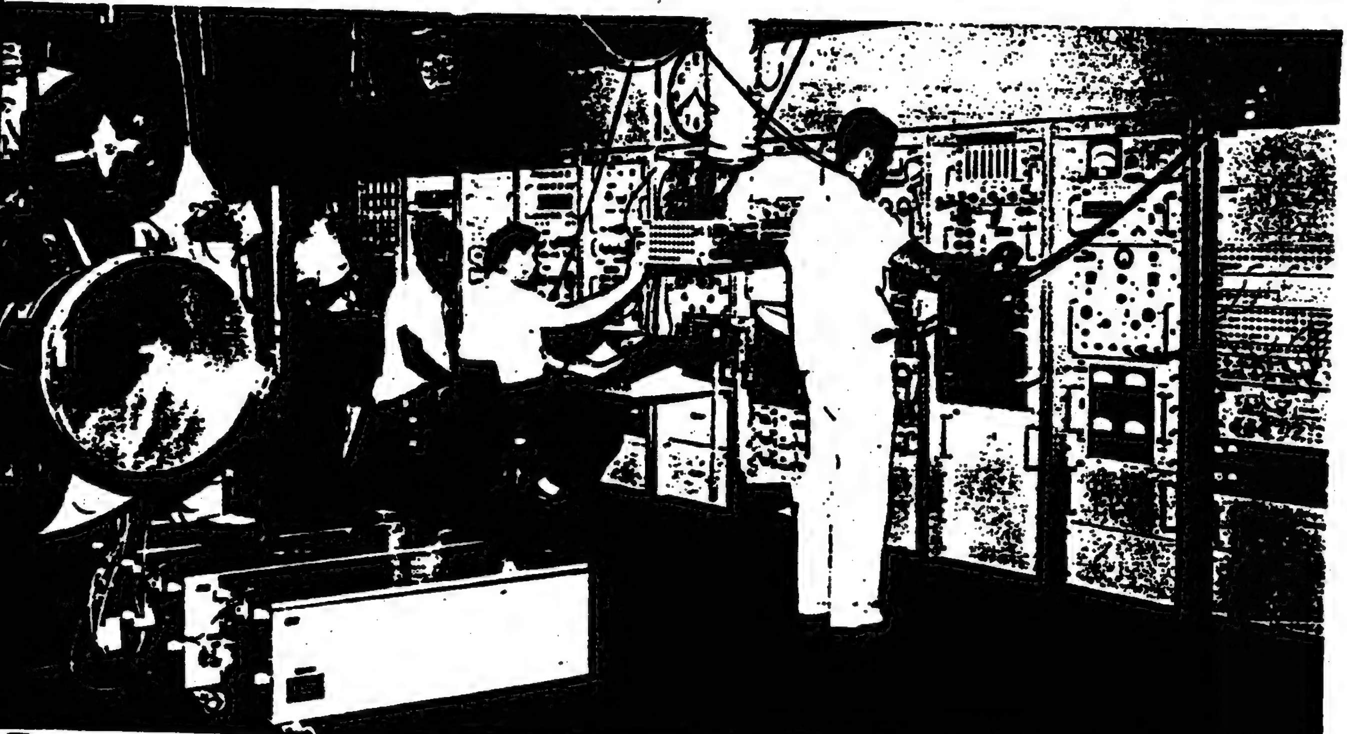


Figure 7. First SAMOS AGENA "A" vehicle during systems testing. Technician at far right is adjusting the UHF ground transmitter to simulate frequencies of the vehicle in orbit. Commands are being sent to the vehicle by the technician on his left. These tests were completed on 1 June.

- Deliveries of flight hardware for the third AGENA "A" vehicle will be completed in July. Late availability of components and the recent strike will require intensive efforts to recover current schedules for this vehicle.

- The first two AGENA "B" vehicles are in the component and subassembly stages of manufacture, with the first scheduled for completion in mid-September. This vehicle is scheduled for launch in April 1961 carrying an E-2 payload.

- Because of the attitude control problem experienced on the second MIDAS flight, the first three SAMOS satellites will maintain a horizontal, nose forward position throughout most of the first orbit. Reorientation to the nose-down position will be initiated by stored commands as the satellite comes within range of the tracking station at Kodiak, Alaska, on its first orbital pass. This change assures completion of tank pressurization venting prior to shutting off the flight control system pneumatics. The forces created by the continuation of venting after switching from the flight control to the attitude damping system are believed to be a major factor in the loss of attitude control. Modifications to the AGENA wiring and airborne components for the first flight article are scheduled to be accomplished during the Vandenberg Air Force Base modification and checkout operation. Modifications for the second and third vehicle will be accomplished at the systems test facility. The AGENA "B" vehicles will incorporate a full-time attitude control system and will not require modification.

Visual Reconnaissance Systems

- *Visual Reconnaissance Systems payloads are being developed in a minimum number of configurations to attain readout and recovery mission objectives. The design and purpose of each configuration is as follows:*

Readout:

E-1—Component Test Payloads

E-2—Steerable Reconnaissance Payload (with 20-foot ground resolution)

Recovery:

E-5—High Resolution, Steerable, Recoverable Payload (with 5-foot ground resolution)

Payloads

- **E-2 Payloads**—Assembly of E-2 payloads continues on schedule at Eastman Kodak. The film drive system and the film processor for the first E-2 payload have completed functional and operational tests successfully. The completed 36-inch focal length camera and lens assembly are undergoing vibration and operational tests at the contractor's facility.

- **E-5 Payloads**—The first test of an E-5 recovery test unit (RETU) is scheduled for July at Edwards Air Force Base. The RETU simulates the E-5 recovery capsule in size, weight and aerodynamic configuration. This test series will determine capsule drag and oscillation characteristics during recovery by a C-130A aircraft. Data from these tests will be used to establish design criteria for the E-5 recovery equipment. Additional RETU tests, including the complete recovery sequence, will be conducted later this year. A mid-February 1961 date has been established for delivery of the first E-5 flight payload.

Ground Support Equipment

- Functional tests of the electronics portion of the vacuum test chamber (used for leak testing E-1 and E-2 payloads) were completed by the contractor and the chamber was delivered to Vandenberg Air Force Base. This completes the delivery of major items of the E-1 payload ground support equipment for the Vandenberg Air Force Base missile assembly building.

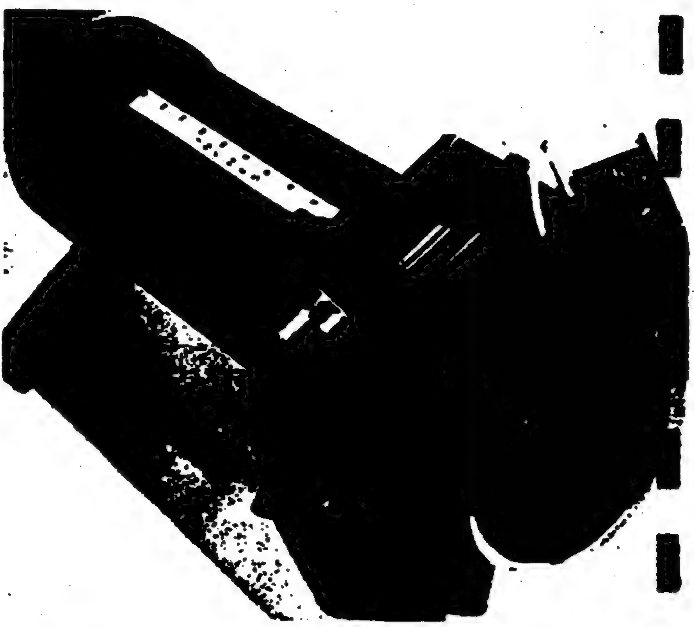


Figure 8. Thirty-six inch focal length camera and lens assembly for E-2 payload. Payload delivery is scheduled for August.

- The first set of E-1/E-2 ground reconstruction electronics (GRE) equipment, primary record camera, and repeater kinescope has been delivered to the Vandenberg Air Force Base missile assembly building. The second set of GRE equipment (backup for the first set) was used for compatibility test with the operating console. At the conclusion of these tests the operating console and the GRE equipment will be shipped to the Vandenberg tracking and acquisition station.

- The 144-inch collimator, to be used for the E-2 payload alignment and checkout, has been completed and will be delivered in July.

Ferret Reconnaissance Systems

- Ferret reconnaissance system payloads are being developed in a minimum number of configurations. The designation and purpose of each configuration is as follows:

F-1—R&D Test Payloads
F-2—Digital General Coverage Payloads
F-3—Specific Mission Payloads—Analog Presentation
F-4—Technical Analysis (study stage only)

Payloads

- **F-2 Payloads**—The testing and assembly of components for the initial F-2 payloads continues on schedule.

Ground Support Equipment

- The first F-2 checkout console has been completed and compatibility tests, using a service test model F-2 payload, are being conducted.

- The logic design for the F-2 data conversion and evaluation equipment has been completed. This equipment will be installed in the Satellite Test Center.

- The major portion of the telemetry data monitoring equipment was delivered to Airborne Instruments Laboratory on 15 June. This equipment will be incorporated into the F-2 evaluation and command complex for the Vandenberg Air Force Base and New Boston tracking and acquisition stations.

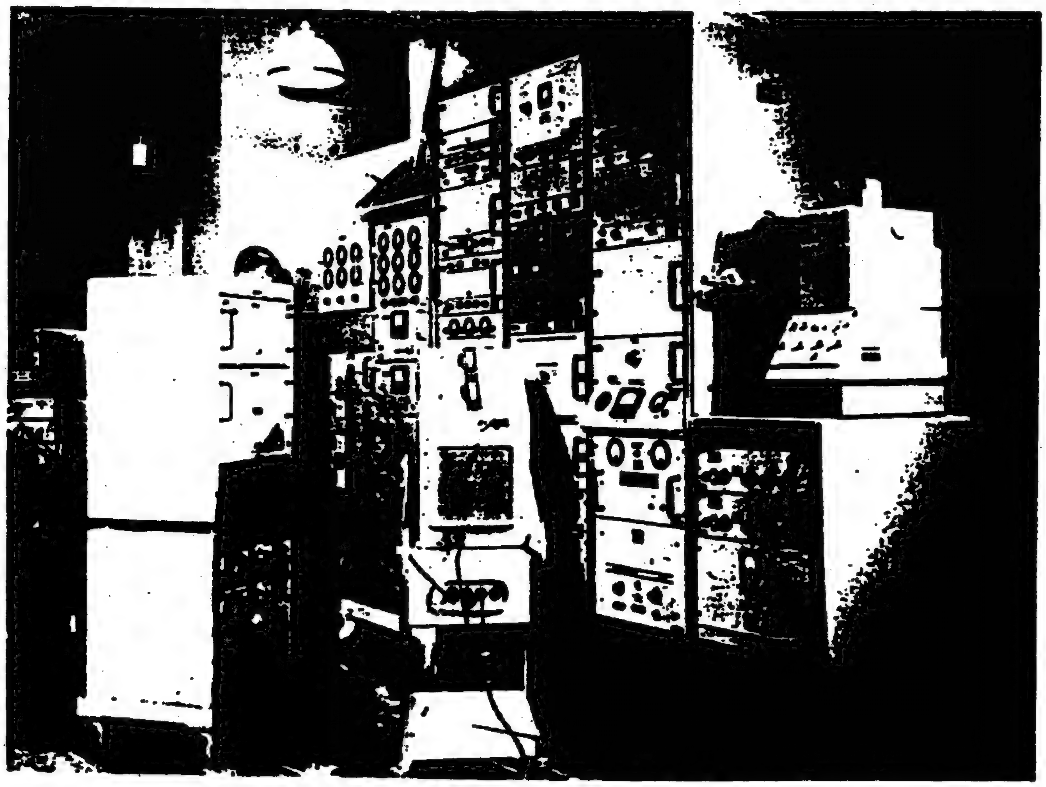


Figure 9. The first set of E-1/E-2 ground reconstruction electronics (GRE) equipment installed in the Vandenberg Air Force Base missile assembly building.

Facilities

- **Vandenberg Air Force Base**—Modifications to accommodate the Model 1604 computer in the Vandenberg Air Force Base data acquisition and processing building have been completed.

- **Satellite Test Center**—Construction of increment 2 to the Satellite Test Center was completed on schedule. Beneficial occupancy began on 16 June and installation of equipment is in progress.

- **Point Arguello**—Installation of all launch operations equipment, propellant loading systems, and high pressure and liquid gas systems has been completed at launch stand 1. System tests of the facility are in progress using ATLAS 57D and the AGENA facilities checkout vehicle. Construction of launch stand 2 is complete, except for the umbilical mast. The mast is scheduled for completion on 6 July.

- **New Boston, New Hampshire, Station**—A change in concepts of computer type and configuration has necessitated the design of a modification to the Data Acquisition and Processing Building. This modification is scheduled for completion in time to support the SAMOS launches.

- **Offutt Air Force Base**—The construction contract for the interim data processing facility was ordered cancelled by the Office of Secretary of Defense. Pending re-direction of the program, no further action will be taken on either the interim or the final facility.

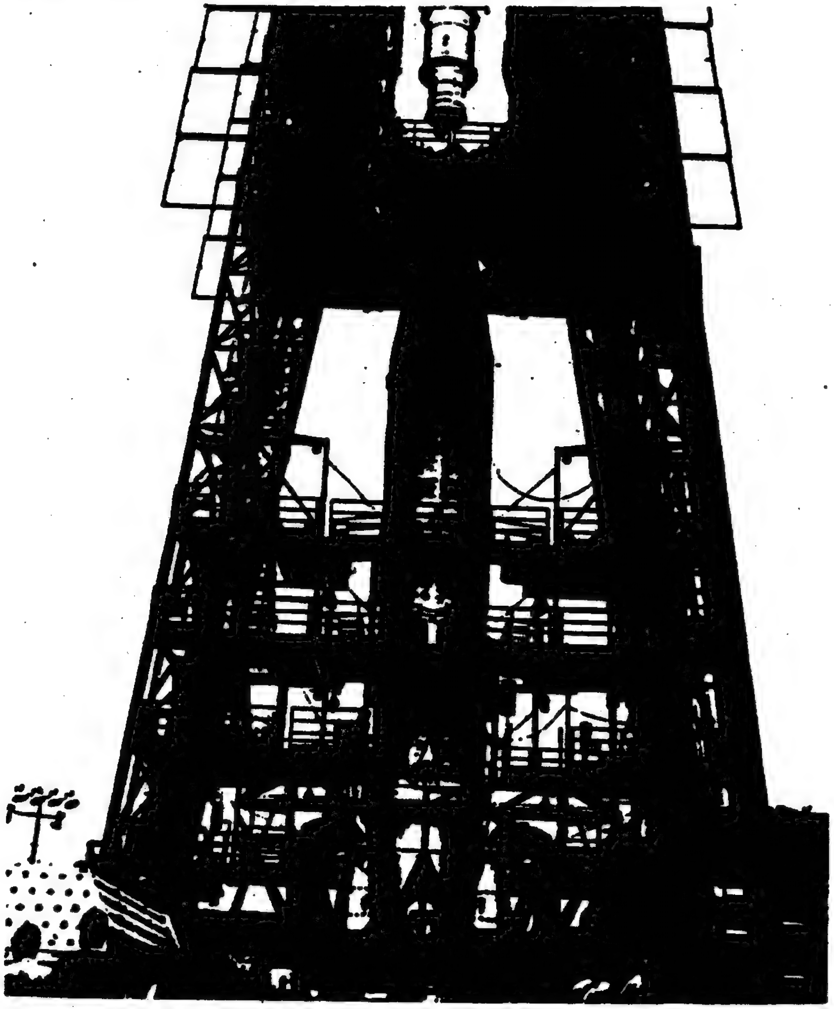
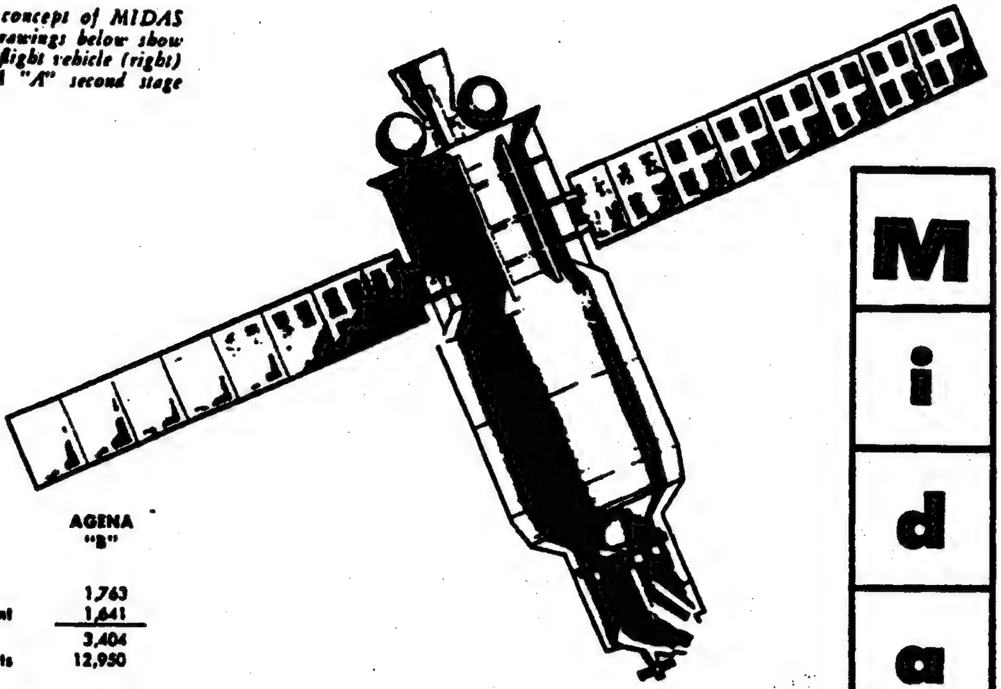


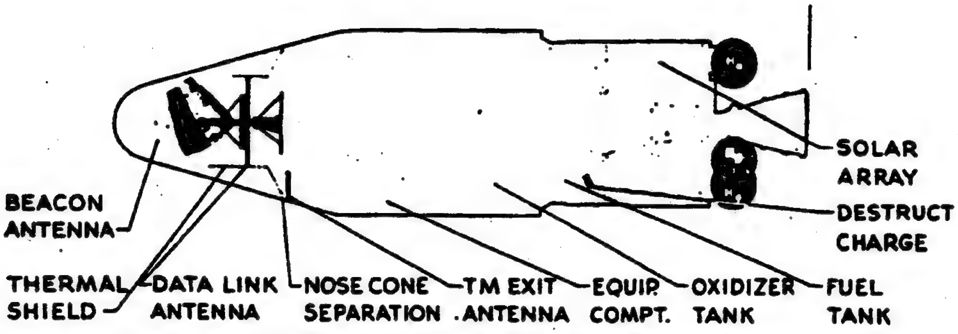
Figure 10. Installing the Agena facilities checkout vehicle on the ATLAS 57D booster prior to systems tests at Point Arguello launch stand 1.

Figure 1. Artist's concept of MIDAS satellite (right). Drawings below show complete two-stage flight vehicle (right) and basic AGENA "A" second stage vehicle (left).

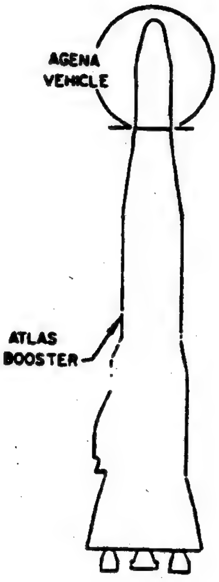


M
i
d
a
s

SECOND STAGE	AGENA "B"
Weight—	
Inert	1,763
Payload equipment	1,641
Orbital	3,404
Impulse Propellants	12,950
Fuel (UDMH)	
Oxidizer (IRFNA)	
Other	758
GROSS WEIGHT (lbs.)	17,112
Engine	XLR81-Ba-9
Thrust, lbs. (vac.)	16,000
Spec. Imp., sec. (vac.)	290
Burn Time, sec.	240
Restart Provisions	Yes



NOTE: AGENA "A" configuration except for solar paddles (AGENA "B" only).



BOOSTER—ATLAS ICBM	
Weight—Wet	15,100
Fuel, RP-1	74,900
Oxidizer (LOX)	172,300
GROSS WEIGHT (lbs.)	262,300
Engine—MA-2	
Thrust (lbs. vac.) Boost	356,000
Sustainer	82,100
Spec. Imp. (sec. vac.) Boost	286
Sustainer	310

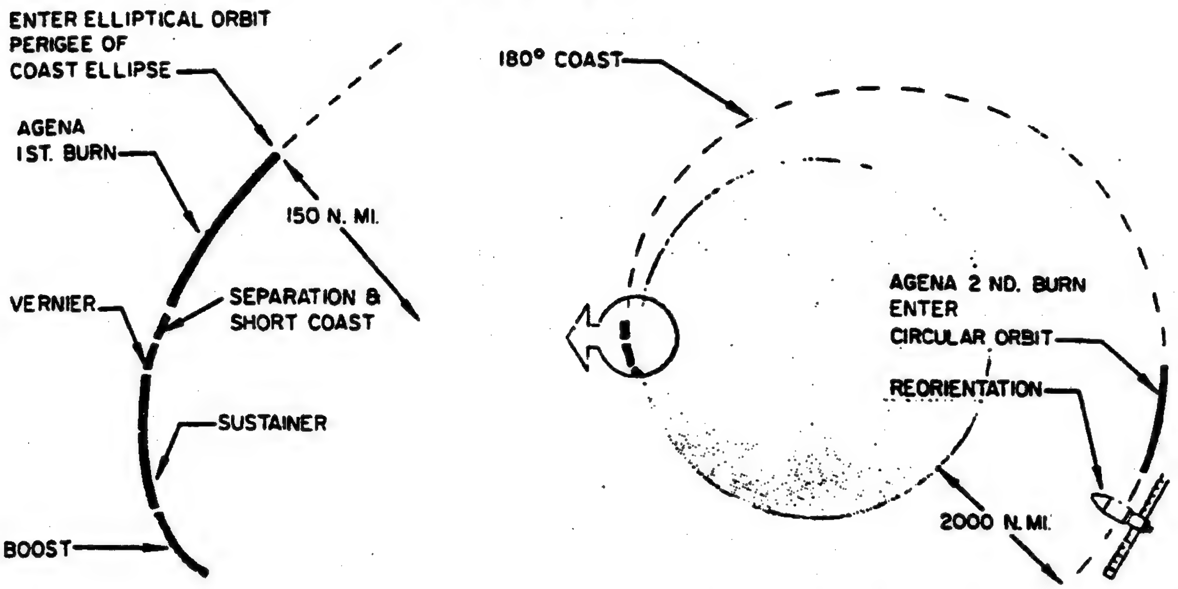


Figure 2.
Launch-to-orbit trajectory for flights 3 and subsequent. Optimum ATLAS boost, guided by radio-inertial system. AGENA ascent (coast, burn, coast, second burn) provides attitude reference. Also governs velocity magnitude and direction by inertial guidance system monitored by horizon scanner. Orbital attitude maintained by reaction wheel and gas jets.

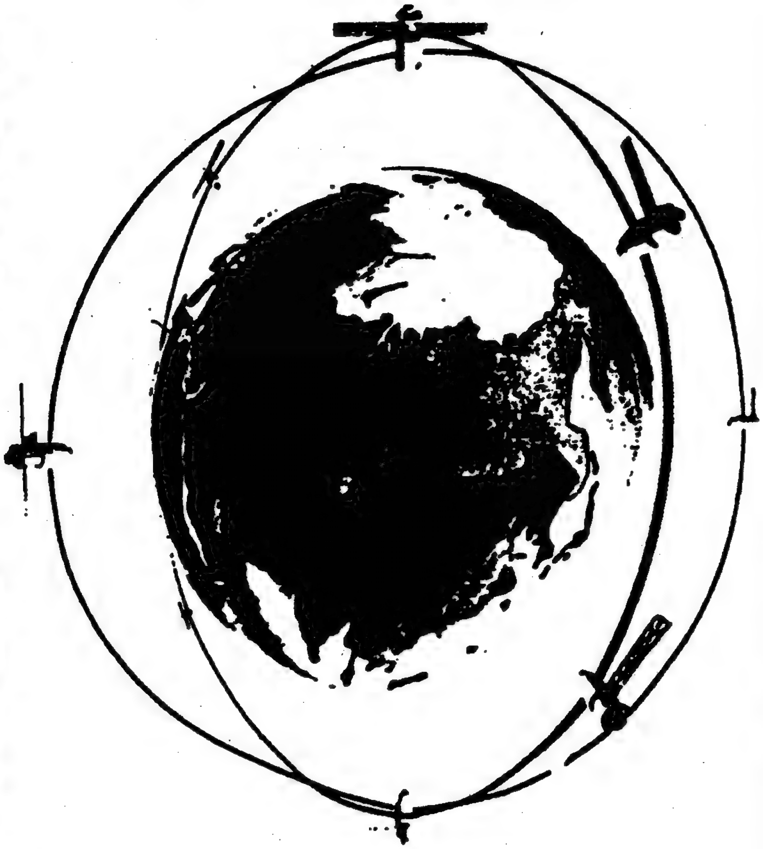
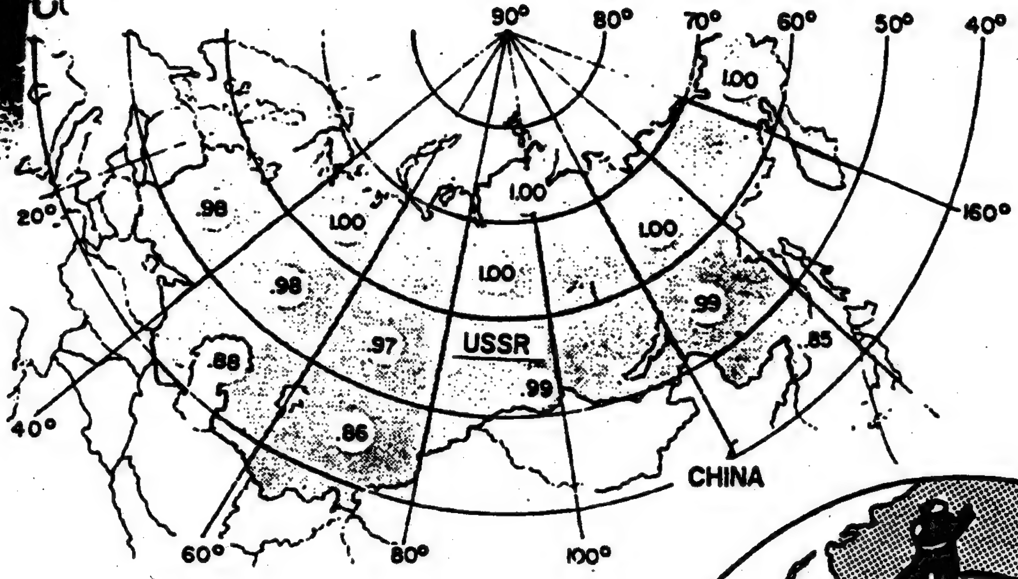


Figure 3.
Proposed MIDAS system. Four satellites spaced equidistant in each of two orthogonal planes at 2,000 n.m. altitude. Provides maximum coverage of USSR with minimum number of satell[illegible]

PROGRAM HISTORY

The MIDAS Program was included in Weapon System 117L when WS 117L was transferred to the Advanced Research Projects Agency. ARPA subsequently separated WS 117L into the DISCOVERER, SAMOS and MIDAS Programs, with the MIDAS objectives based on an infrared reconnaissance system. The MIDAS (Missile Defense Alarm System) Program was directed by ARPA Order No. 38, dated 5 November 1958 until transferred to the Air Force on 17 November 1959. A ten launch development plan for MIDAS (WS-239A) has been approved. This R&D Program should make possible the achievement of an operational system by 1963.

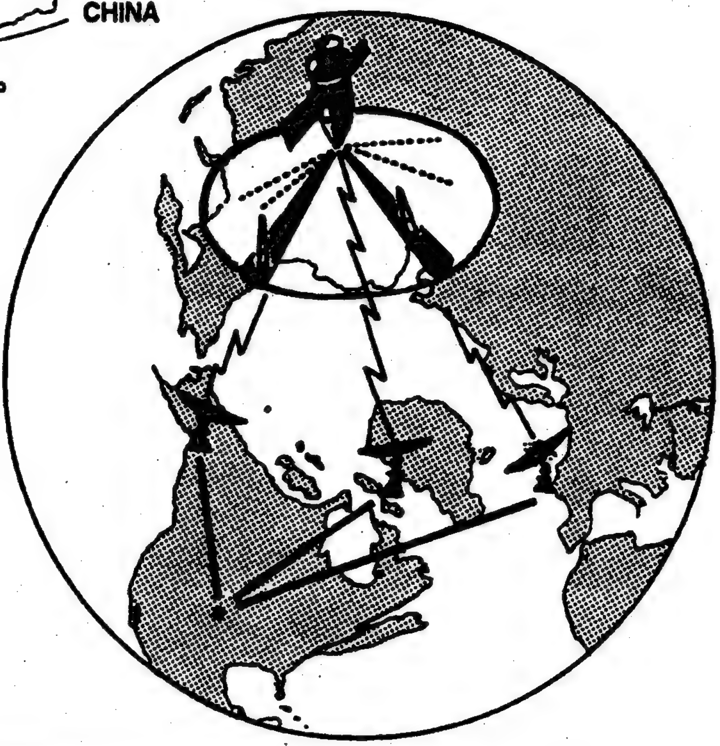


CONDITIONS:
2,000 n.m. altitude
Two orthogonal polar orbital planes, four equi-spaced satellites in each plane.
Readout Stations
United Kingdom
North Atlantic
Ft. Greeley, Alaska

Ft. Greely, Alaska

:ude and
y horizon
heel and

Figure 4.
Orbiting satellites detect infrared radiation emitted by Soviet ICBM's in powered flight. Data telemetered instantaneously to MIDAS Control Center via far north readout stations. Decoded data reveal approximately the number of missiles launched and launch location, direction of travel and burning characteristics. Probabilities of less than 1.00 on the above map indicate the probability of at least one MIDAS satellite detecting an ICBM launch. Probabilities of 1.00 indicate that more than one MIDAS satellite will always be in position to detect an ICBM launch. These figures are based on geometric considerations of the family of satellites and ground readout station locations.



'eapon
sferred
Agency.
7L into
AS Pro-
sed on
n. The
n) Pro-
No. 38,
rred to
. A ten
S (WS-
rogram
t of an

TECHNICAL HISTORY

The MIDAS infrared reconnaissance payload is engineered to use a standard launch vehicle configuration. This consists of a "D" Series ATLAS missile as the first stage and the AGENA vehicle, powered by a Bell Aircraft rocket engine as the second, orbiting stage (Figure 1). The total payload weight is approximately 1,000 pounds.

The first two of the ten R&D flights used the AGENA "A" vehicle programmed to place the payload in a circular 261 nautical mile orbit. Subsequent flights will utilize the ATLAS/AGENA "B" configuration which will be programmed to place the payload in a circular 2,000 nautical mile polar orbit.

MIDAS I, launched in February 1960, did not attain orbit because of a failure during ATLAS/AGENA separation.

MIDAS II, launched in May 1960, was highly successful. Performance with respect to programmed orbital parameters was outstanding. Useful infrared data were observed and recorded.

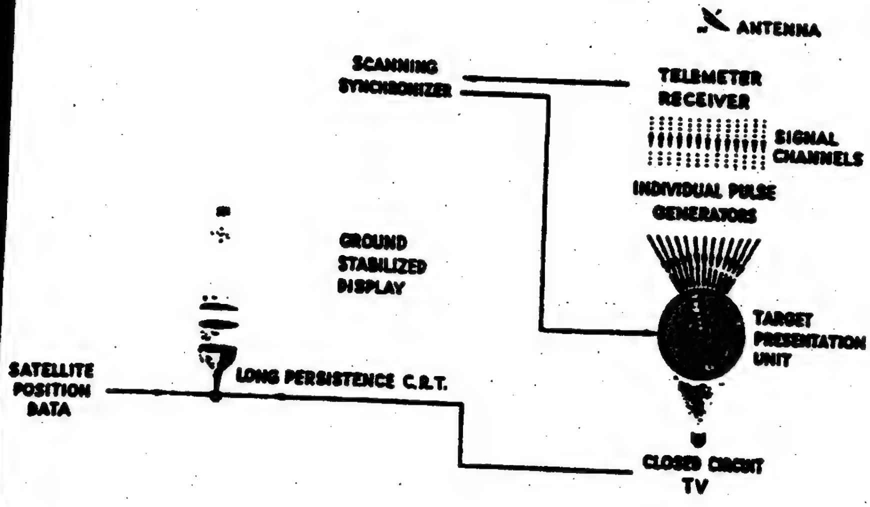
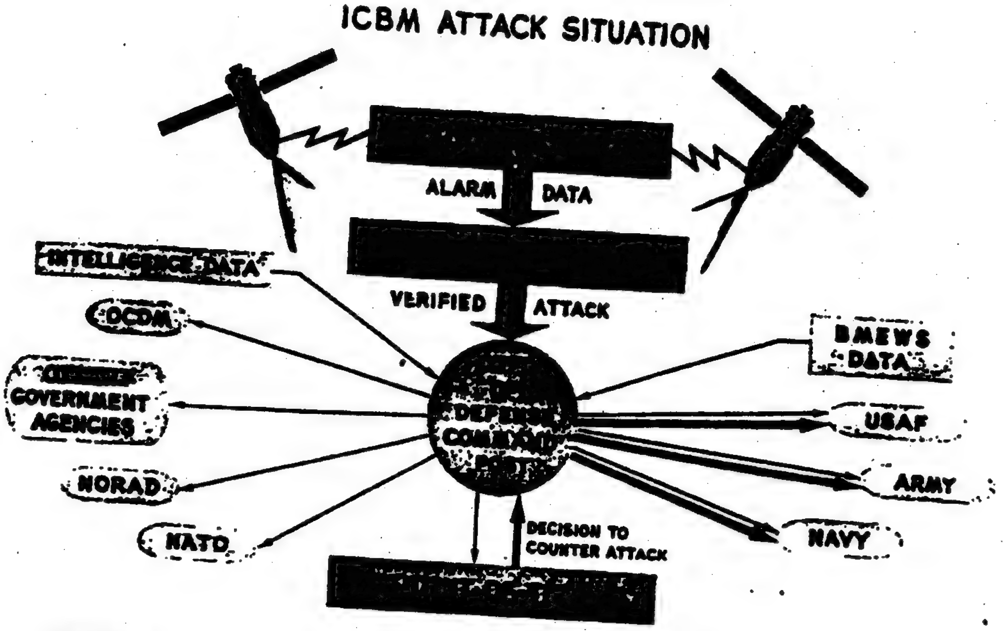
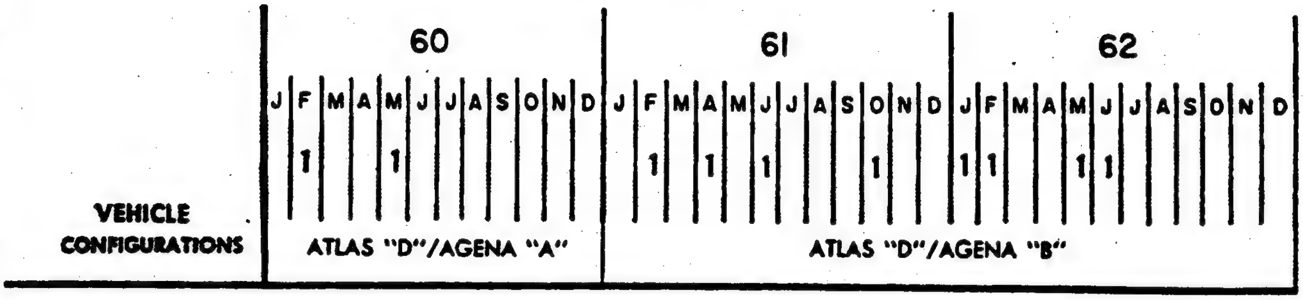


Figure 5.
Simplified version of ground presentation system (left) for display of infrared reconnaissance data. The data is displayed on a TV monitor with a map overlay. The chart below shows data flow from the readout stations to decision-making agencies. The MIDAS Control Center, or other using agencies having a correlated ground stabilized display, can determine when an actual attack has been launched.



CONCEPT

The MIDAS system is designed to provide continuous infrared reconnaissance of the Soviet Union. Surveillance will be conducted by eight satellite vehicles in accurately positioned orbits (Figure 3). The area under surveillance must be in line-of-sight view of the scanning satellite. Mission capabilities are shown in Figure 4. The system is designed to accomplish instantaneous readout of acquired data by at least one of three strategically located readout stations. The readout stations transmit the data directly to the MIDAS Control Center where it is processed, displayed, and evaluated (Figure 5.) If an attack is determined to be underway, the intelligence is communicated to a central Department of Defense Command Post for relay to the President and all national retaliatory and defense agencies.



MIDAS Launch Schedule

MONTHLY PROGRESS—MIDAS Program

Flight Test Progress

- The second MIDAS flight test vehicle was launched from Pad 14, Atlantic Missile Range (AMR), on 24 May. Booster performance was highly satisfactory, with booster, sustainer, and vernier engine cutoffs occurring as programmed. Ascent trajectory was near nominal. The separation sequence was satisfactorily accomplished. Satellite engine ignition occurred within one second of nominal and engine shutdown was initiated at the proper velocity. The resulting orbit was the most perfect circular orbit achieved by the United States, with an apogee of 280 nautical miles and a perigee of 254 nautical miles. The orbital life is expected to be 40 months. Approximately 75 percent of the test objectives were

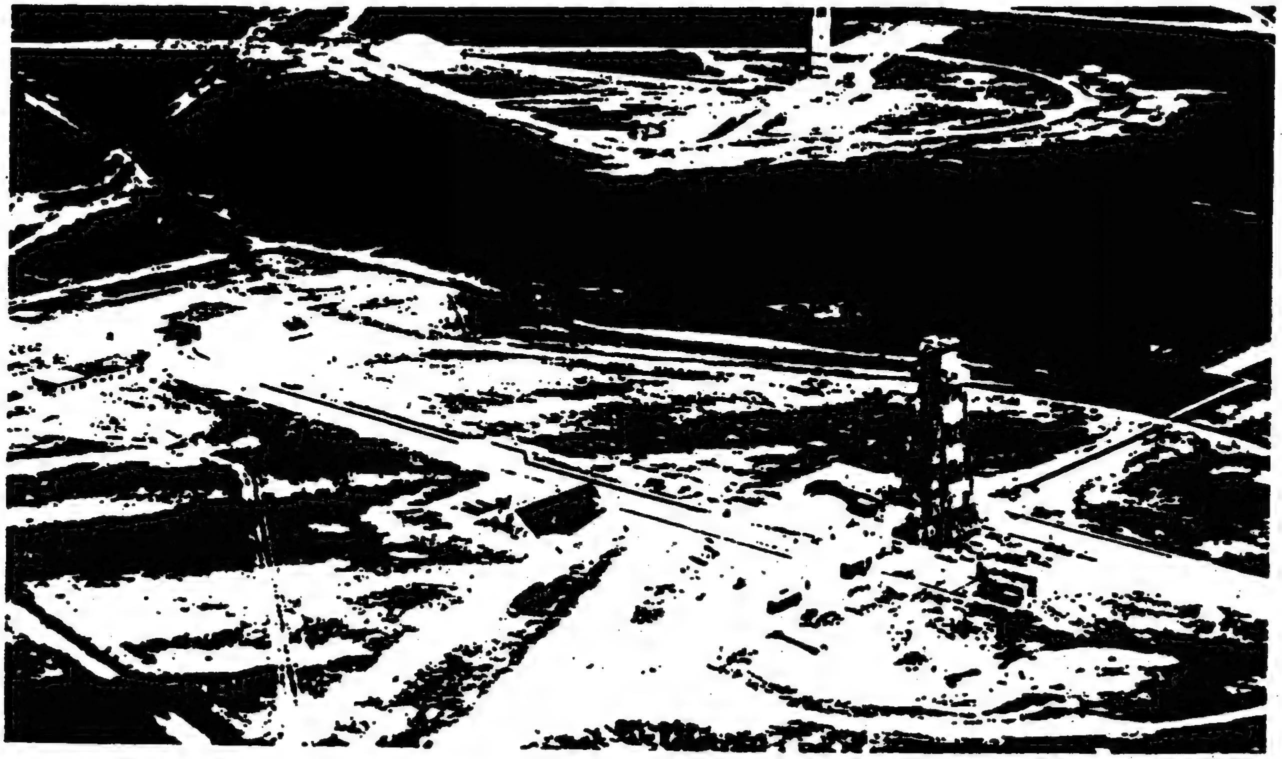


Figure 6. Aerial view showing Atlantic Missile Range Complex 14 in the foreground. The gantry and launch stand are on the right. The blockhouse is on the left.

attained. Major problem areas during the test were in-orbit stabilization and communications.

- Although payload and vehicle transmission ceased after the thirteenth pass, some telemetry from the solar auxiliary power under test system (SAPUT) has continued. The purpose of the SAPUT system is to evaluate three types of solar cell coating materials. Because of a failure in the telemetry switching system, only one channel of SAPUT information was received subsequent to orbit pass number one. Transmission characteristics of the SAPUT telemetry provided useful indications of the in-orbit motions of the satellite.

Technical Progress

Second Stage Vehicles

- Fabrication of the AGENA "B" vehicle for the third MIDAS flight was proceeding on schedule; however, indications are that a schedule slippage will be incurred if the present strike at LMSD is not ended quickly. Installation of the engine has been started and assembly of the wiring harness is nearing completion.

- The electromechanical equipment that provides directional positioning of the solar auxiliary power array has successfully completed approximately 1000 hours of continuous cycling.

Infrared Scanner Units

Infrared scanner units for flights 3, 4, and 5 are being manufactured by Baird-Atomic, Inc.

- Manufacture of the first Baird-Atomic, Inc. infrared payload is behind schedule and slippages have occurred in delivery dates for the first three units. This slippage can be partially attributed to deficiencies in the turret bearing and drive motor which were identified during acceptance testing of the thermomechanical equivalent of the Baird-Atomic payload.

- Negotiations have been completed with Aerojet-General Corporation for the development of a service test model of an advanced infrared scanner planned for later MIDAS flights. This model will contain special instrumentation for engineering and life testing and will not be a flight article.

Facilities

- Southeast African station — Responsibility for selection, construction and operation of this station has been assigned to the Atlantic Missile Range. AFBMD will provide design criteria and technical equipment to establish this station.

AFBMD Activities in Space, Jul 60 [redacted]

SATELLITE
systems

DISCOVERER
SAMOS
MIDAS
COMMUNICATIONS
SATELLITE

Discoverer

The DISCOVERER Program consists of the design, development and flight testing of 35 two-stage vehicles, using the THOR IRBM as the first stage booster and the AGENA as the second stage, satellite vehicle. The program was established early in 1958 under direction of the Advanced Research Project's Agency, with technical management assigned to AFBMD. On 14 November 1959, program responsibility was transferred from ARPA to the Air Force by the Secretary of Defense. Prime contractor for the program is Lockheed Missile and Space Division. The DISCOVERER Program will perform space research in support of the advanced military reconnaissance satellite programs.

PROGRAM OBJECTIVES

(a) Flight test of the satellite vehicle airframe, propulsion, guidance and control systems, auxiliary power supply, and telemetry, tracking and command equipment.

(b) Attaining satellite stabilization in orbit.

(c) Obtaining satellite internal thermal environment data.

(d) Testing of techniques for recovery of a capsule ejected from the orbiting satellite.

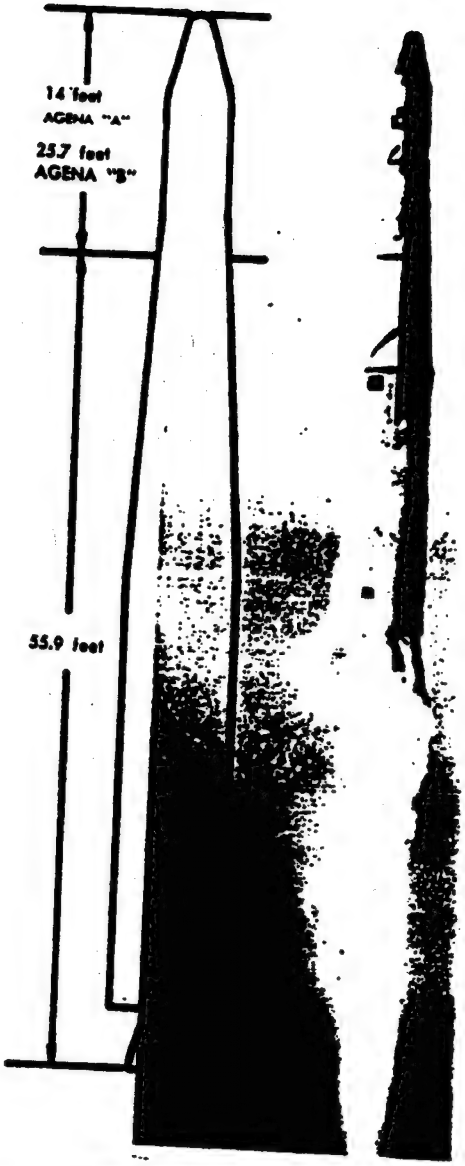
(e) Testing of ground support equipment and development of personnel proficiency.

(f) Conducting bio-medical experiments with mice and small primates, including injection into orbit, re-entry and recovery.

PROGRAM SUMMARY

Early launches confirmed vehicle flight and satellite orbit capabilities, developed system reliability, and established ground support, tracking and data acquisition requirements. Later in the program, biomedical and advanced engineering payloads will be flight tested to obtain support data for more advanced space systems programs. DISCOVERER vehicles are launched from Vandenberg Air Force Base, with overall operational control exercised by the Satellite Test Center, Palo Alto, California.

Tracking and command functions are performed by the stations listed in the Table on page A-4. A history of DISCOVERER flight to date is given on page A-5.



SECOND STAGE	AGENA "A"	AGENA "B"	
Weight—			
Inert	1,262	1,328	1,346
Payload equipment	497	887	915
Orbital	1,759	2,215	2,216
Impulse propellants	6,525	12,950	12,950
Other	378	511	511
TOTAL WEIGHT	8,662	15,676	15,722
Engine Model	YLR81-Ba-5	XLR81-Ba-7	XLR81-Ba-9
Thrust-lbs., vac.	15,600	15,600	16,000
Spec. Imp.-sec., vac.	277	277	290
Burn time-sec.	120	240	240

THOR BOOSTER	DM-18	DM-21
Weight—Dry	6,950	6,500
Fuel	33,700	33,700
Oxidizer (LOX)	68,200	68,200
GROSS WEIGHT (lbs.)	108,850	108,400
Engine	MB-3 Block 1	MB-3 Block 2
Thrust, lbs. (S.L.)	152,000	167,000
Spec. Imp., sec. (S.L.)	247.8	248.3
Burn Time, sec.	163	148

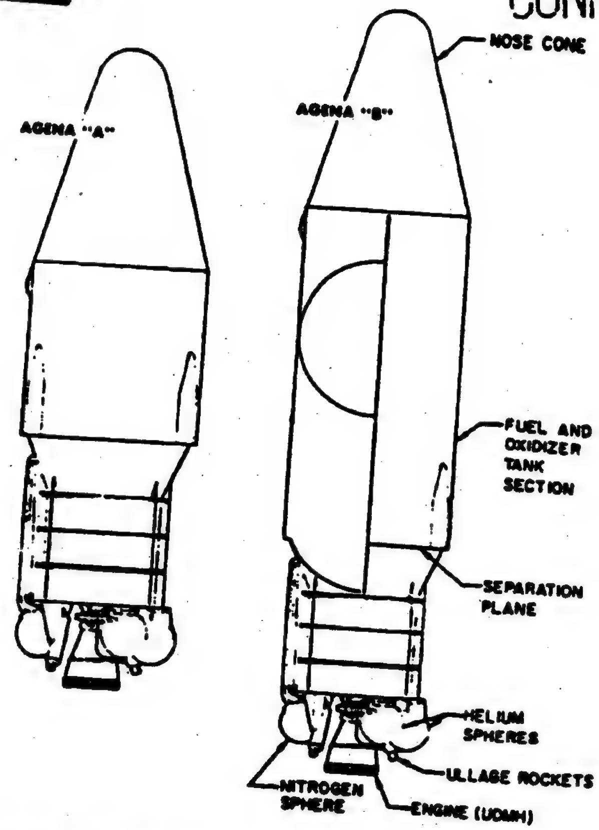
Telemetry ships are positioned as required by the specific mission of each flight. Figures 2 and 3 show a typical launch trajectory from Vandenberg Air Force Base, and figure 3 shows schematically a typical orbit. An additional objective of this program is the development of a controlled re-entry and recovery capability for the payload capsule (Figure 4). An impact area has been established near the Hawaiian Islands, and a recovery force activated. Techniques have been developed for aerial recovery by C-119 aircraft and for sea recovery by Navy surface vessels. The recovery phase of the program has provided advances in re-entry vehicle technology. This information will be used in support of more advanced projects, including the return of a manned satellite from orbit.

FLIGHT VEHICLE

The three versions of flight test vehicles used in the DISCOVERER Program are defined in the launch schedule shown on page A-5. Specifications for the two THOR configurations and three AGENA configurations used are given on page A-1.

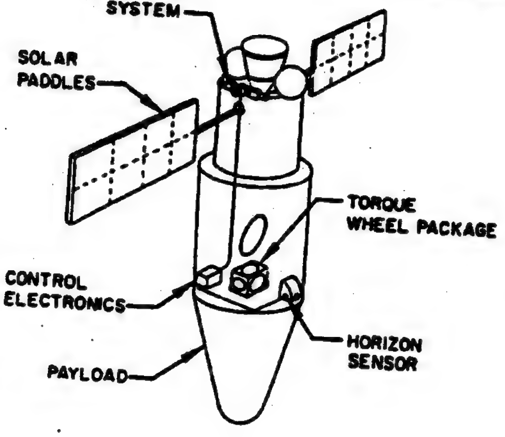
AGENA VEHICLE DEVELOPMENT

The AGENA vehicle was originally designed by the Air Force as the basic satellite vehicle for Advanced Military Reconnaissance Satellite Systems Programs. Basic design was based on use of the ATLAS ICBM as the first stage. ATLAS trajectory characteristics and the stringent eccentricity requirements of the advanced programs led to the selection of a guidance system suited to achieving orbital injection in a horizontal attitude. As a result, an optical inertial system was developed for vehicle guidance and a gas jet system for orbital attitude control. An urgent need for attaining higher altitude orbits resulted in development of the AGENA "B" versions. The YLR81 Ba-5 version of the LR81-Ba-3 engine (Bell Hustler engine developed for B-58 aircraft) is used on AGENA "A" vehicles. The YLR81-Ba-5 version of this engine was developed to provide increased performance through the use of unsymmetrical di-methyl hydrazine (UDMH) fuel instead of JP-4.



Early AGENA "B" vehicles will use the YLR81-Ba-7 version of this engine. The majority of AGENA "B" vehicles will use the XLR81-Ba-9 engine incorporating a nozzle expansion ratio of 45:1, and providing a further increase in performance capability including engine restart and extended burn capability.

SAMOS and MIDAS AGENA VEHICLE

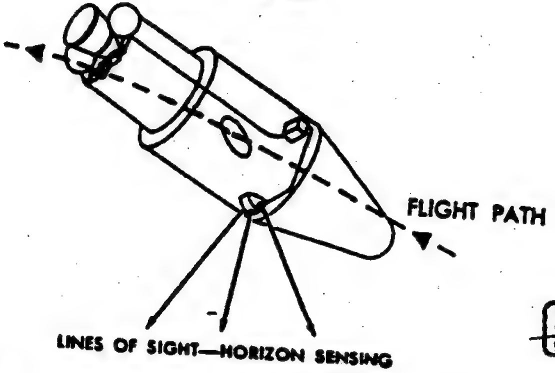


PERFORMANCE CAPABILITIES

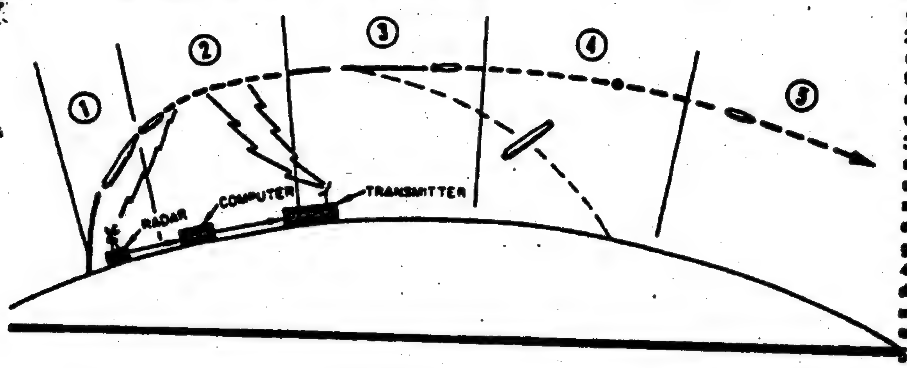
ALTITUDE
200–20,000 MILES

ATTITUDE
ROLL – 0.1 DEGREE
PITCH – 0.1 DEGREE
YAW – 1 DEGREE

DISCOVERER/AGENA



Powered Flight Trajectory



1. **First Stage Powered Flight**—2.5 minutes duration, 78 n.m. downrange, guided by programmed auto pilot.
2. **Coast Period**—2.4 minutes duration, to 380 n.m. downrange; altitude controlled by inertial reference package, horizon scanner, gas reaction jets. Receives AGENA time to fire and velocity to be gained commands.
3. **Second Stage Powered Flight**—2 minutes duration, to 770 n.m. downrange. Guided and controlled by inertial reference package, horizon scanner, gas reaction jets (roll) gimballing engine, yaw and pitch accelerometer—integrated.
4. **Vehicle Reorients to Nose Aft**—2 minutes duration, to 2,000 n.m. downrange. Guided and attitude controlled by inertial reference package, horizon scanner and gas reaction jets.
5. **In-Orbit**—Controlled (same as 4).

UEL AND
OXIDIZER
TANK
SECTION

PARATION
ANE

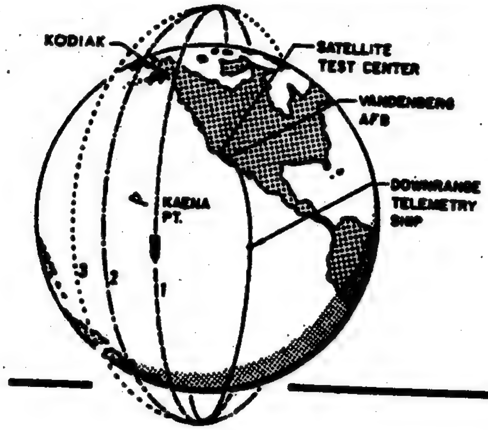
M
RES

E ROCKETS

MH)

ent
in
31
er
on
his
n-
yl

-7
,"
g
a
g

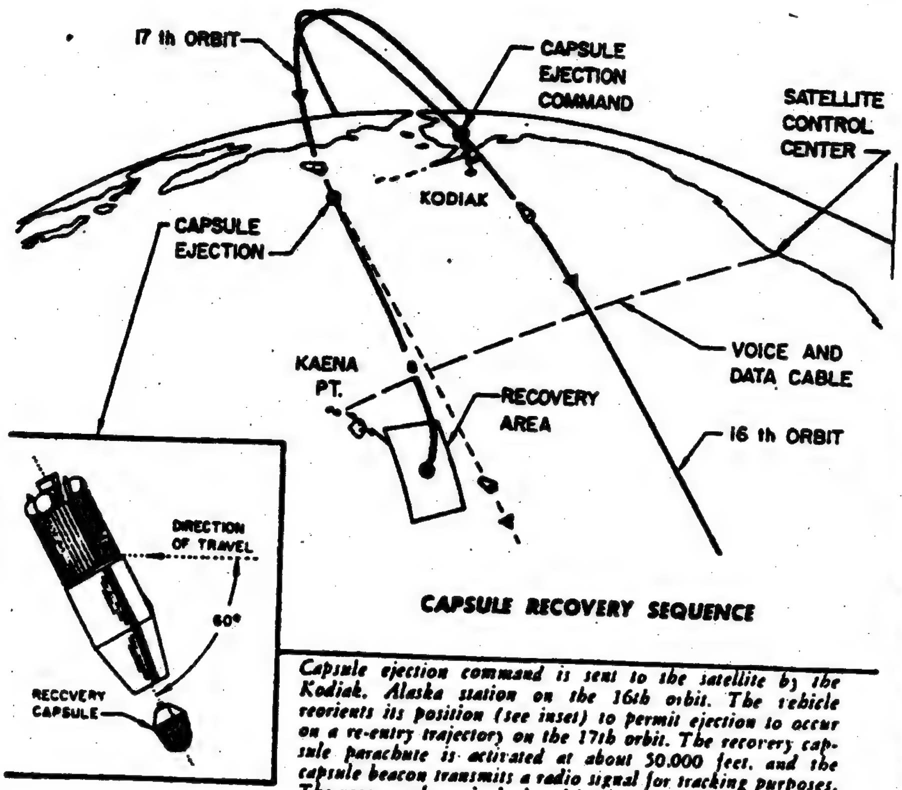


Orbital Trajectory

Schematic presentation of orbital trajectory following launch from Vandenberg Air Force Base. Functions performed by each station and a listing of equipment used by each station is given on page A-4.

RECOVERY CAPABILITY

This objective was added to the program after the first launch achieved vehicle flight and orbit objectives successfully. It includes the orientation of the satellite vehicle to permit a recoverable capsule to be ejected from the nose section of the AGENA vehicle. Ejection is programmed to occur on command on the 17th orbit, for capsule impact within the predetermined recovery area south of Hawaii. Aircraft and surface vessels are deployed within the area as a recovery force.



CAPSULE RECOVERY SEQUENCE

Capsule ejection command is sent to the satellite by the Kodiak, Alaska station on the 16th orbit. The vehicle reorients its position (see inset) to permit ejection to occur on a re-entry trajectory on the 17th orbit. The recovery capsule parachute is activated at about 50,000 feet, and the capsule beacon transmits a radio signal for tracking purposes. The recovery force is deployed in the recovery (impact) area.

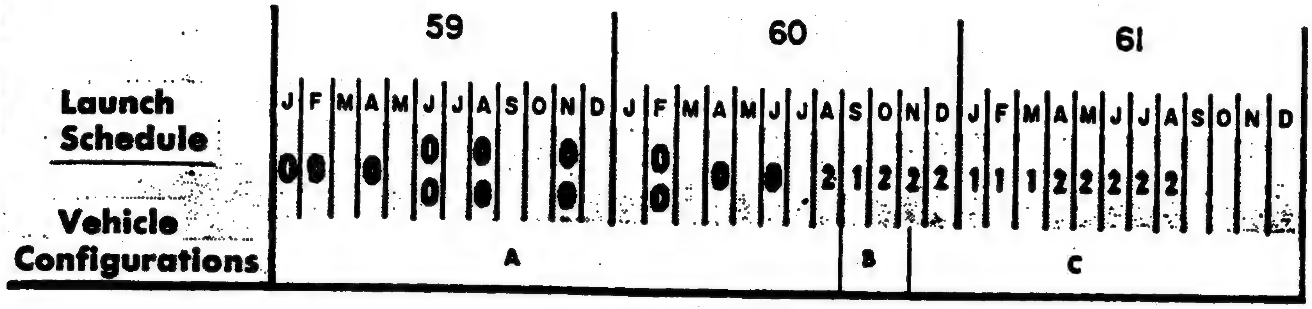
PATH

Facility	Equipment*	Flight Function
Satellite Test Center	A	Over-all control, convert tracking stations data to obtain a predicted orbit and generate subsequent ephemerides issue acquisition data to tracking stations for subsequent passes, predict recovery area.
Vandenberg AFB	BCDEFGHIJK	Launch, ascent and orbital tracking, telemetry reception, trajectory measurements including time to ignite second stage.
Point Mugu	BCDEFGHIJKL	Ascent tracking and telemetry data reception, transmits command to ignite and shut down AGENA (via guidance computer).
Telemetry Ship (Pvt. Joe E. Mann)	DF	Final stage ascent tracking and telemetry data reception.
Kodiak, Alaska (tracking station)	BDEFGHIJK	Orbital tracking and telemetry data reception, including first pass acquisition, recovery capsule ejection and impact prediction.
Kaena Point, Oahu, Hawaii (tracking station)	BCDEFGHIJK	Orbital tracking and telemetry data reception.
Hickam AFB, Oahu, Hawaii		Over-all direction of capsule recovery operations.

Equipment

A. 2 UNIVAC 1103-A digital computers
B. VERLORT (Modified Mod II) radar
C. TLM-18 self-tracking telemetering antenna
D. Tri-helix antenna
E. Doppler range detection equipment
F. Telemetry tape recording equipment
G. Telemetry decommutators for real time data presentation
H. Plot boards for radar and TLM-18 tracking data
I. Conversion equipment for teletype transmission of radar, TLM-18 and doppler tracking data in binary format
J. Acquisition programmer for pre-acquisition direction of antennas
K. Ground command to satellite transmission equipment
L. Guidance computer

GROUND SUPPORT FACILITIES



A. THOR—DM-18 / AGENA "A"

B. THOR—DM-21 MB-3 Block 1 / AGENA "B" XLR81-Ba-7

C. THOR—DM-21 MB-3 Block 2 / AGENA "B" XLR81-Ba-9

0 Attained orbit successfully.

● Failed to attain orbit.

Flight History

DISCOVERER No.	AGENA No.	THOR No.	Flight Date	Remarks
0	1019	160	21 January	*AGENA destroyed by malfunction on pad. THOR refurbished for use on flight XII.*
I	1022	163	28 Feb 1959	*Attained orbit successfully. Telemetry received for 514 seconds after lift-off.*
II	1018	170	13 April	*Attained orbit successfully. Recovery capsule ejected on 17th orbit was not recovered. All objectives except recovery successfully achieved.*
III	1020	174	3 June	*Launch, ascent, separation, coast and orbital boost successful. Failed to achieve orbit because of low performance of satellite engine.*
IV	1023	179	25 June	*Same as DISCOVERER III.*
V	1029	192	13 August	*All objectives successfully achieved except capsule recovery after ejection on 17th orbit.*
VI	1028	200	19 August	*Same as DISCOVERER V.*
VII	1051	206	7 November	*Attained orbit successfully. Lack of 400-cycle power prevented stabilization on orbit and recovery.*
VIII	1050	212	20 November	*Attained orbit successfully. Malfunction prevented AGENA engine shutdown at desired orbital velocity. Recovery capsule ejected but not recovered.*
IX	1052	218	4 February	*THOR shut down prematurely. Umbilical cord mast did not retract. Quick disconnect failed, causing loss of helium pressure.*
X	1054	223	19 February	*THOR destroyed at T plus 56 sec. by Range Safety Officer.*
XI	1055	234	15 April	*Attained orbit successfully. Recovery capsule ejected on 17th orbit was not recovered. All objectives except recovery successfully achieved.*
XII	1053	160	29 June	*Launch, ascent, separation, coast and orbital stage ignition were successful. Failed to achieve orbit because of AGENA attitude during orbital stage boost.*

Monthly Progress—DISCOVERER Program

Flight Test Progress

- The launch of DISCOVERER XIII is scheduled for 10 August. DISCOVERER XIV is scheduled for 18 August.

- DISCOVERER XIII will carry a diagnostic payload in addition to the normal recovery equipment. This payload contains instrumentation to determine capsule environment and the functioning of separation and recovery sequence events. A five-channel telemetry system is installed to transmit this data. To assure receipt of all data, a tape recorder is provided to record the real time events and capsule performance during the telemetry "blackout" period which occurs when the capsule re-enters the atmosphere. After a two-minute time delay, this stored data will be transmitted. The high speed of re-entry induces ionization over the skin of the capsule which effectively blocks telemetry transmission. An S-band transponder is also provided to aid in tracking the capsule from ejection through recovery.

Technical Progress

Second Stage Vehicles

- Three AGENA "B" vehicles (XLR-81-Ba-7 engines) are now in storage following Air Force acceptance.

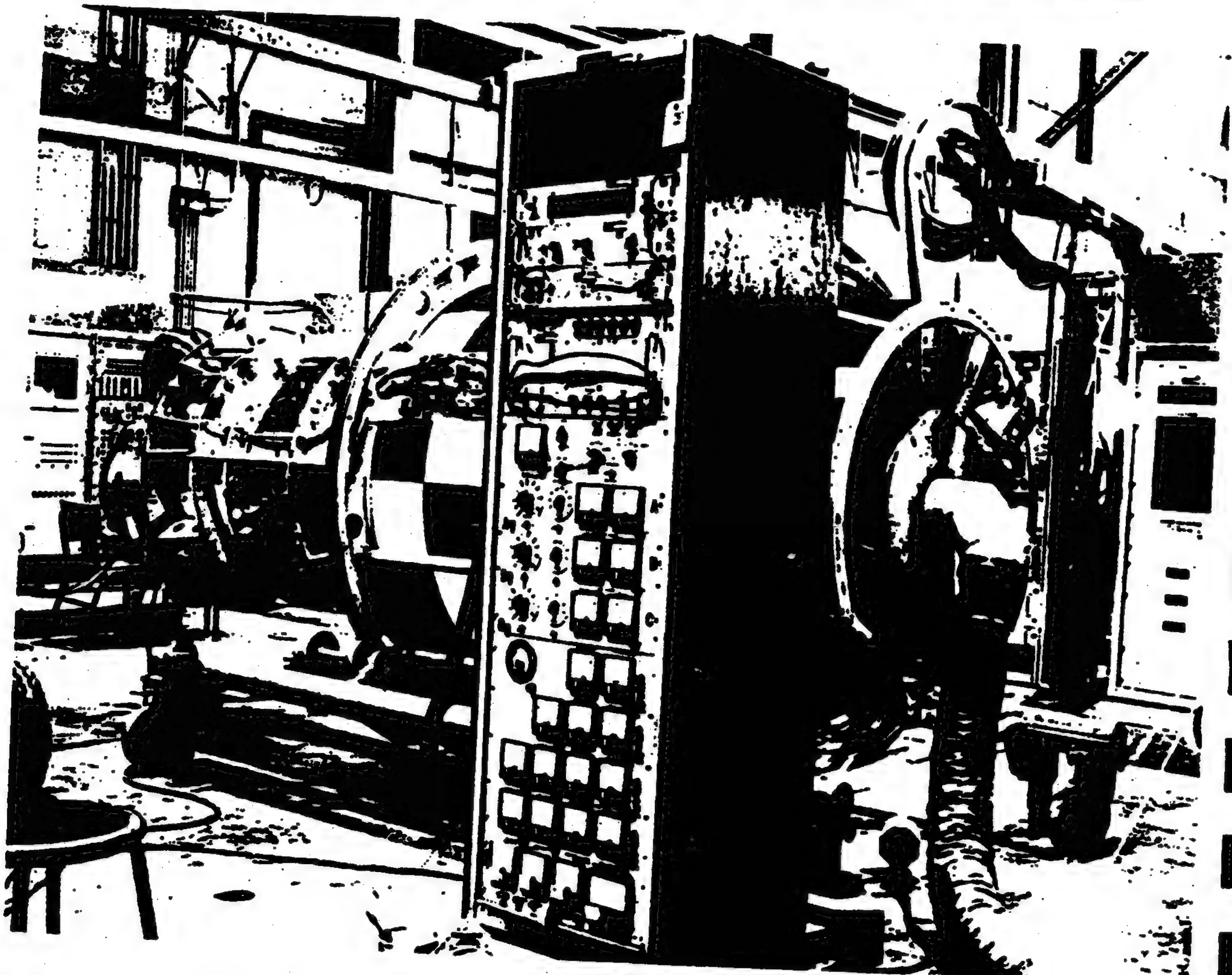


Figure 1. DISCOVERER XIII AGENA "A" vehicle (No. 1059) undergoing systems tests in the missile assembly building at Vandenberg Air Force Base. Following these checks the fairings will be installed and the vehicle will be transported to the launch pad for installation on the THOR booster. DISCOVERER XIII is scheduled for launch on 10 August.

These vehicles will be moved to the Vandenberg Air Force Base missile assembly building as required for launch. The first two AGENA "B" vehicles using the XLR-81Ba-9 engine are undergoing hot firing acceptance tests at Santa Cruz Test Base.

RF Interference Test Program

- The cause of improper horizon scanner operation during the DISCOVERER XII flight was determined to be RF interference from the satellite telemetry transmitter. A modification has been incorporated to correct this condition. Subsequent testing has revealed on RF interference with the scanner at any frequency or transmitter power level.

Recovery System Component Test Program

- The third and fourth successful balloon drops of the recovery system series were made at Holloman Air Force Base on 23 and 27 July. The retro rocket and spin/de-spin systems functioned satisfactorily. These were the second and third successful dynamic tests of the "cold gas" spin system. In both test chaff was dispensed from the pilot chute deployment bag and did not contact the main chute, indicating that the prior interference problem has been solved.

BOOSTER—ATLAS ICBM	
Weight—Wet	15,100
Fuel, RP-1	74,900
Oxidizer (LOX)	172,300
GROSS WEIGHT (lbs.)	262,300
Engine—MA-2	
Thrust (lbs. vac.) Boost	356,000
Sustainer	82,100
Spec. Imp. (sec. vac.) Boost	286
Sustainer	310

SECOND STAGE	AGENA "A"	AGENA "B"
Weight—		
Inert	1,508	1,695
Payload equipment	2,605	3,058
Orbital	4,113	4,753
Impulse Propellants	6,492	12,950
Fuel (UDMH)		
Oxidizer (IRFNA)		
Other	606	718
GROSS WEIGHT (lbs.)	11,211	18,421
Engine	YLR81-Ba-5	XLR81-Ba-9
Thrust, lbs. (vac.)	15,600	16,000
Spec. Imp., sec. (vac.)	277	290
Burn Time, sec.	120	240

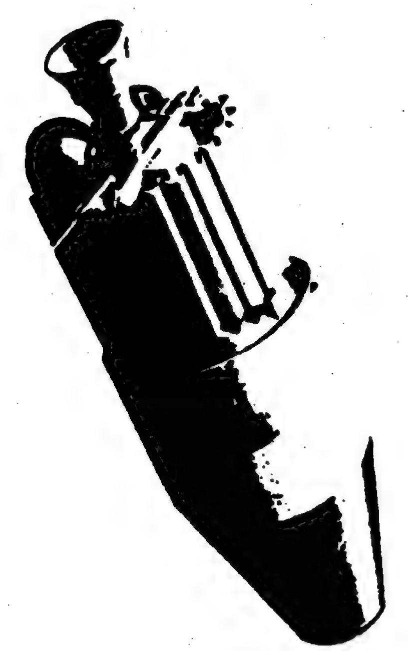
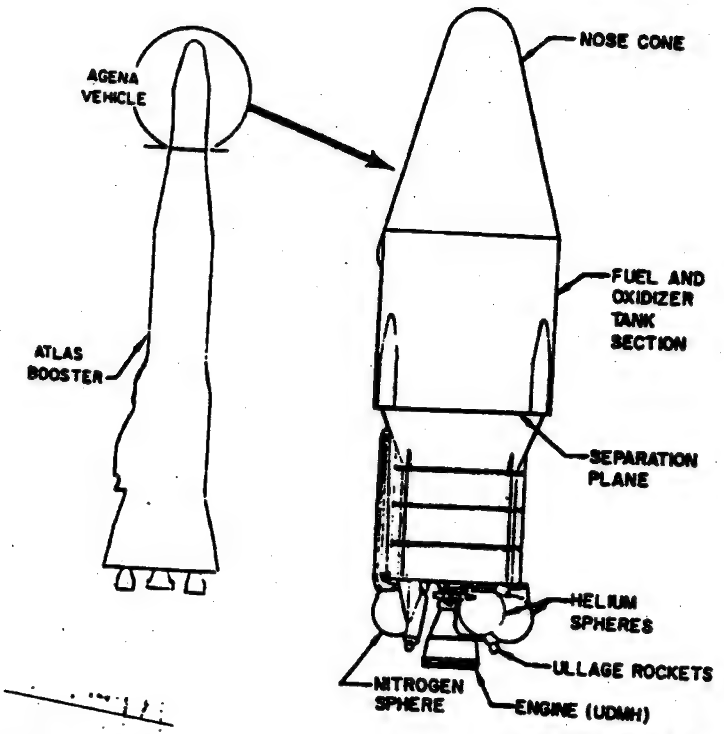


Figure 1.

Artists' concept of SAMOS satellite. Line drawing of complete flight vehicle (right) and detailed view of basic AGENA upper stage (left).



PROGRAM HISTORY

The SAMOS Program was included in Weapon System 117L when WS 117L was transferred to the Advanced Research Projects Agency early in 1958. ARPA separated WS 117L into the DISCOVERER, SAMOS and MIDAS programs with the SAMOS objectives based on a visual and ferret reconnaissance system. On 17 November 1959 responsibility for this program was transferred from ARPA to the Air Force by the Secretary of Defense.

PROGRAM MISSION

The primary mission of the SAMOS advanced reconnaissance system is to provide visual and electronic coverage of the USSR and its allied nations. Efforts include development of hardware to permit:

a. Determination of characteristics of enemy electronic emissions.

b. Verification of known targets, detection of unknown targets.

c. Location and evaluation of defenses.

d. Evaluation of military and industrial strength.

e. Assessment of high-yield weapons damage.

f. Reconnoitering of troop movements.

g. Location of naval forces throughout the world.

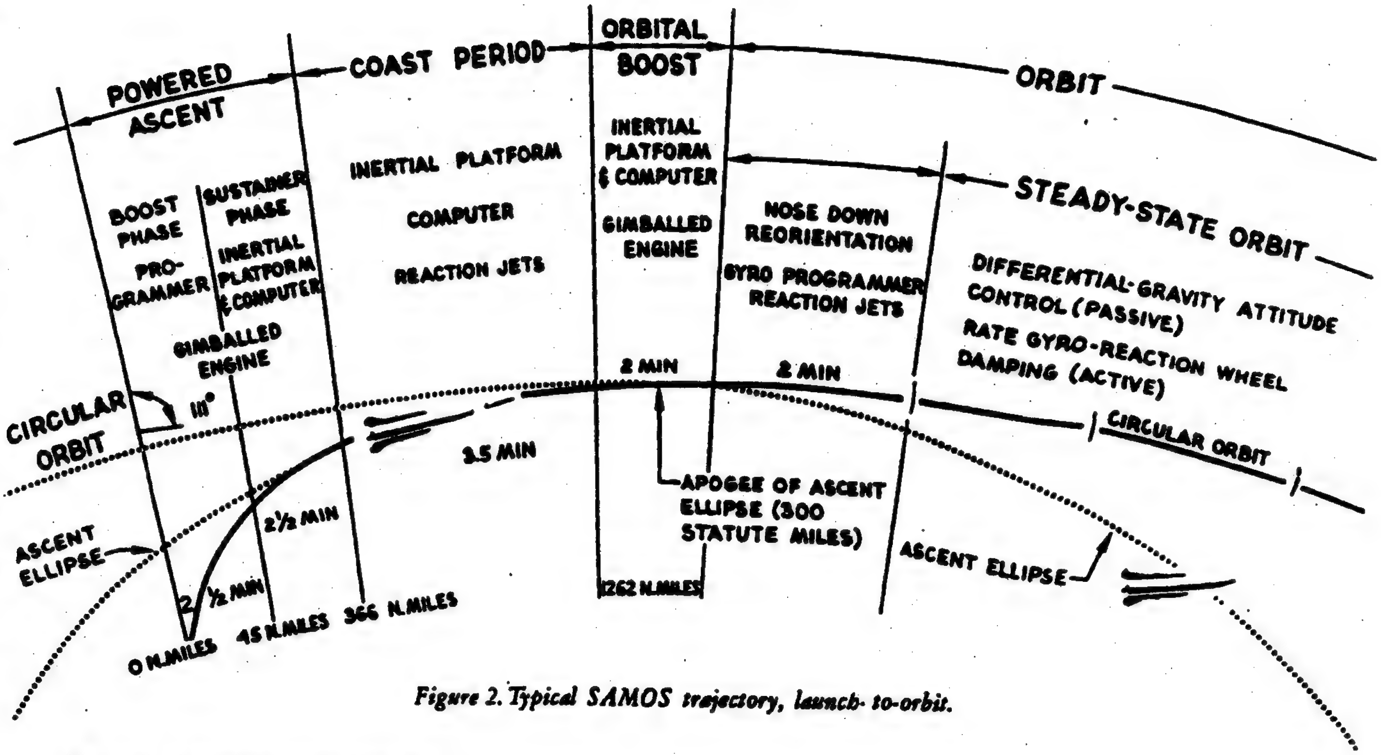


Figure 2. Typical SAMOS trajectory, launch- to-orbit.

Ferret Reconnaissance...

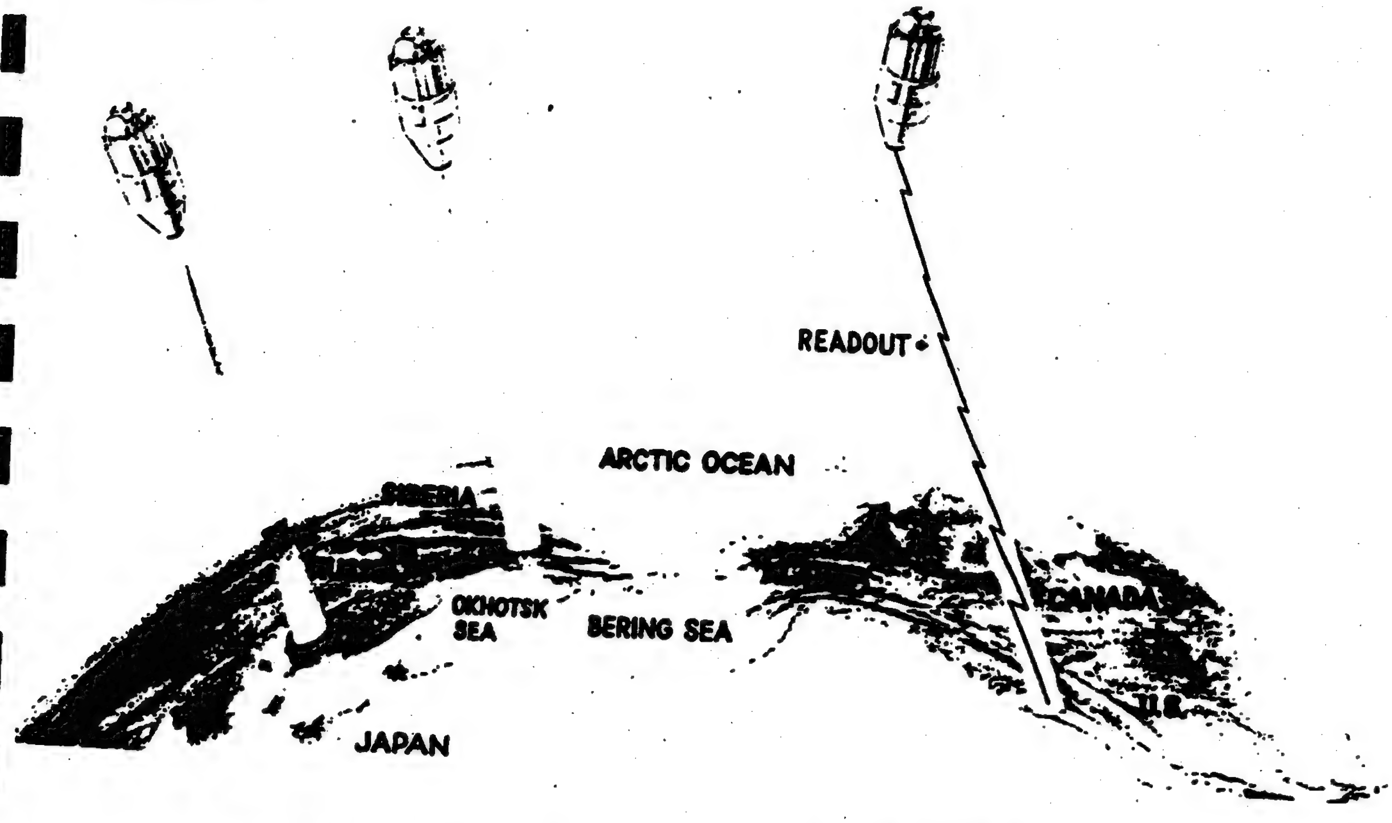


Figure 4. The Ferret reconnaissance system will gather data from electronic emissions over areas of interest.

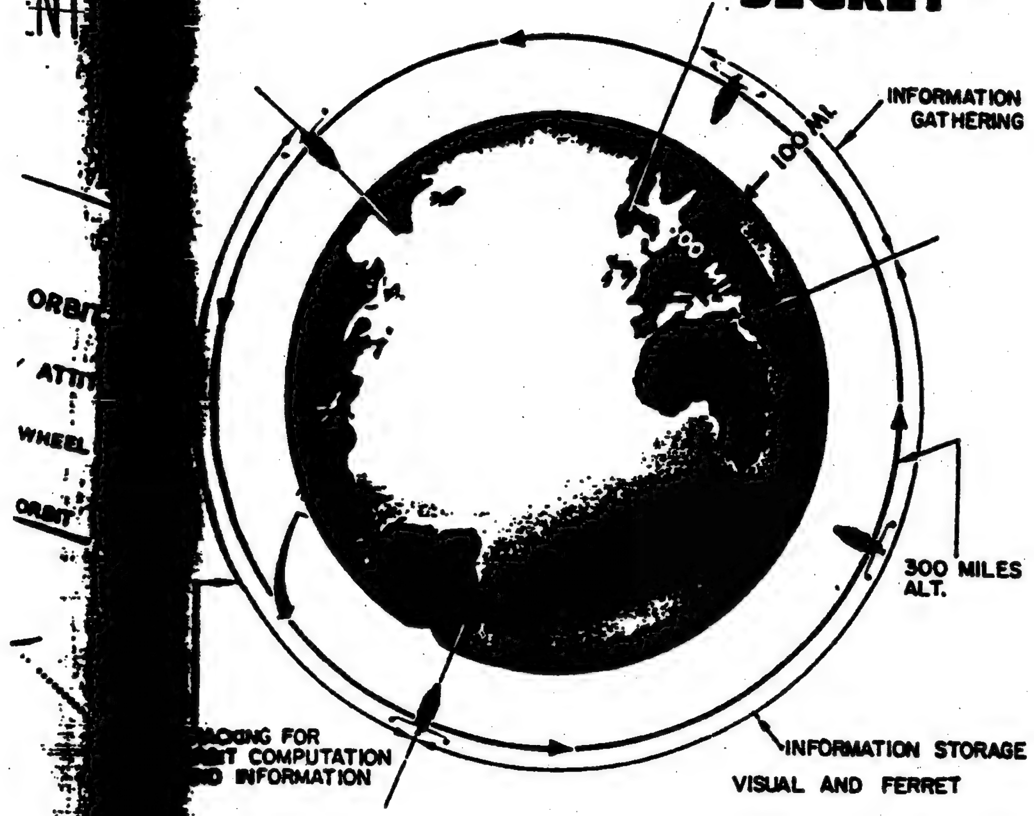


Figure 3.
Schematic of SAMOS system in operational orbit. When the satellite is over the area of interest the sensing equipment is turned on (Information gathering). When it leaves the area of interest the sensing equipment is turned off and the sensing data is processed (Information storage). When the vehicle comes within range of a ground receiving station, the data will be read-out upon command for processing and transmitted to using agencies. This process is continuously repeated during the useful lifetime of the vehicle.

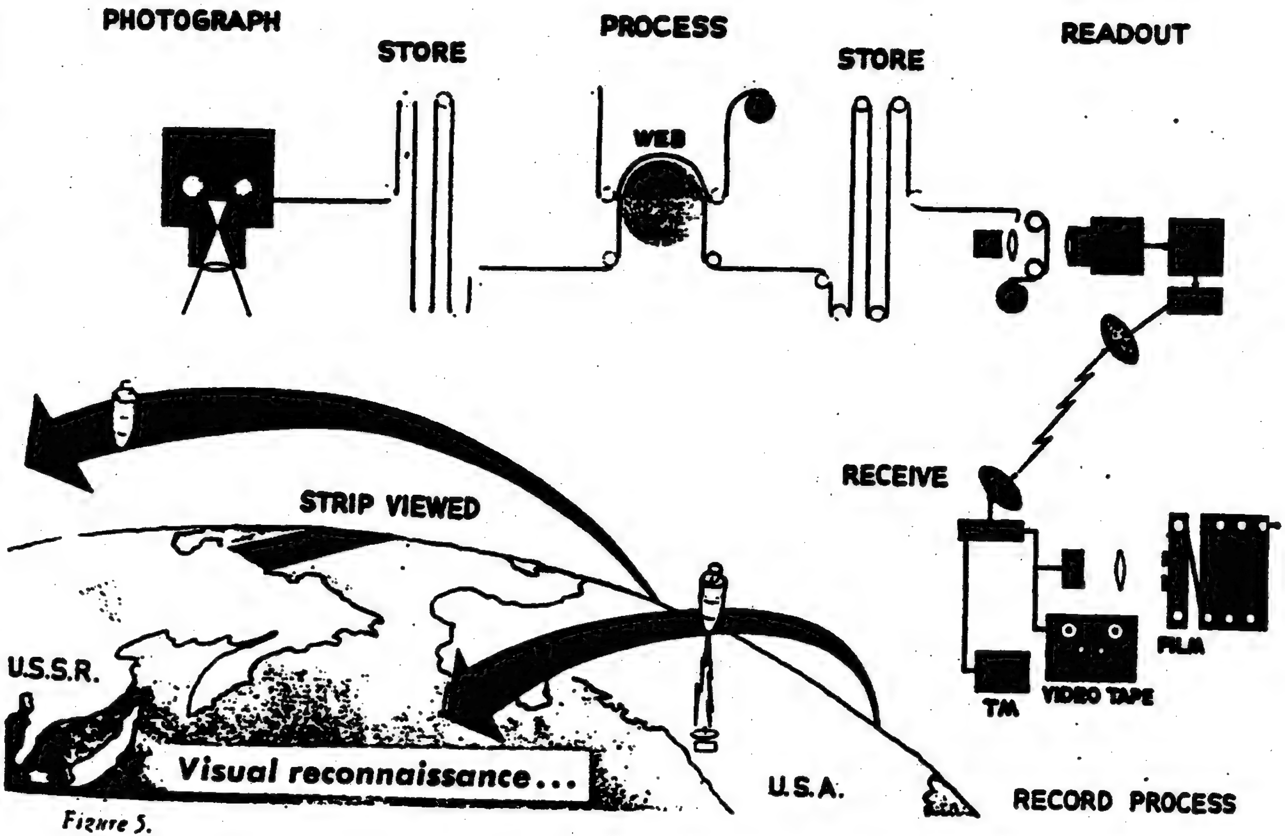


Figure 5.
The initial visual reconnaissance program will use conventional photo techniques with automatic film processing and TV-type electronic image readout to ground stations thru a data link. Ground electronics will reconvert the signal into photo image form, with a capability of resolving objects 20 feet in length.

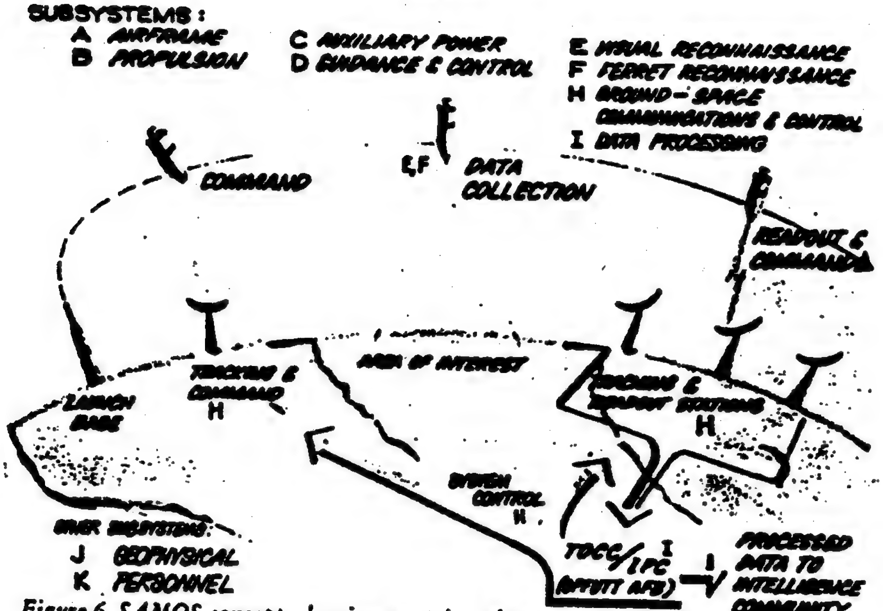


Figure 6. SAMOS concept, showing reception of commands and transmission of data between satellite and ground station; and subsystem functions (schematic).

For economical testing of components a dual-capability visual and ferret payload will be used during the early development phase. On later flights only a visual or ferret system payload will be carried. These payloads will be housed in the AGENA vehicle (Figure 1).

Data collected by the visual payloads will be electronically transmitted in the readout system and retrieved in the recovery system. Ferret data will be transmitted electronically. These systems are composed of the AGENA vehicle, ATLAS booster, launch facilities, tracking facilities, and a communications and data processing network. The recovery system will also include a re-entry capsule and a recovery force.

CONCEPT

ATLAS Series D missiles launched from VAFB will boost the AGENA vehicle into polar orbits. Injection into near-circular orbits (Figure 2) will be accomplished by the AGENA vehicle rocket engine. A self-contained guidance system using a horizon reference scanner will provide altitude stabilization. As the satellite travels in an orbit essentially fixed in space the earth rotates inside the orbit (Figure 3). Each successive orbit is displaced laterally approximately 23½ degrees at the equator, permitting one vehicle to observe the entire earth in a time period dependent upon the width of the area under surveillance. Early versions will have a useful life of approximately ten days. Later versions will have a useful life of four months with a design objective in certain configurations of one year; recovery systems will have a useful life of fifteen to thirty days.

TECHNICAL DESCRIPTION

Visual Program—Three versions (E-1, E-2, and E-5) of visual payloads are being developed. The E-1 payload is a photo component test payload which is combined with the F-1 ferret payload. The E-2 photographic payload, under development by Eastman Kodak Company, includes a camera, film processor, and electronic readout equipment. The E-5 recoverable system designed by Lockheed will retain the exposed film and the 66-inch focal length camera developed by Itek Corporation.

Ferret Program—Ferret payloads are being developed on a progressively more advanced basis from R&D (F-1) to advanced systems (F-4). The F-2 all-digital, general coverage payload will use superheterodyne scanning receivers in conjunction with directional antennas, an analog to digital converter and tape recorders (for storage). A programmer will be used to control read-in over areas of interest and readout over tracking stations. The F-3 payload will use similar receivers with stop-scan capability and controllable antennas added. Recording of the actual signal intercepted (rather than the digital representation) will be possible with a bandwidth up to 6mc. A complex programmer will permit satellite search of a given area or frequency range.

	J	F	M	A	M	J	J	A	S	O	N	D
60									1		1	
61	1			1		1		1	1	1	1	2
62		1		2		1	2	2	1	1	2	2

VEHICLE CONFIGURATIONS	ATLAS "D"/AGENA "A"	ATLAS "D"/AGENA "B"

SAMOS Launch Schedule

Monthly Progress—SAMOS Program

Technical Progress

Second Stage Vehicles

- The AGENA vehicle for the first SAMOS flight was delivered to Vandenberg Air Force Base following successful captive hot firing tests and completion of dynamic systems testing at Santa Cruz Test Base. The vehicle is proceeding on schedule through modification and subsystem bench testing in the missile assembly building. Although impeded by parts shortages and the recent strike, schedules are being maintained to assure transfer of the vehicle to the launch pad by 19 August.

- The AGENA vehicles for the second and third flights are currently in the modification and subsystem test phases at the systems test area. Both vehicles are behind schedule because of the recent one-month strike and parts shortages. Efforts to recover current schedules are dependent upon continued availability of airborne communications equipment. The second flight vehicle is short the UHF narrow-band and wide-band data link transmitters. A firm delivery date is not available from the narrow-band transmitter contractor; however, a backup flight unit was received on 25 July. Delivery of a wide-band transmitter to replace the one used in the first flight vehicle has been made. The third flight vehicle has eight major airborne communications equipment shortages. Since delivery of these units is not expected before mid-August, it is doubtful that the schedule can be recovered.

- The first AGENA "B" vehicle is in the major subassembly phase of manufacture. Assembly was delayed by the recent strike, but every effort is being made to regain the schedule.

Visual Reconnaissance Systems

Visual Reconnaissance Systems payloads are being developed in a minimum number of configurations to attain readout and recovery mission objectives. The design and purpose of each configuration is as follows:

Readout:
- E-1—Component Test Payloads
- E-2—Steerable Reconnaissance Payload (with 20-foot ground resolution)

Recovery:
- E-5—High Resolution, Steerable, Recoverable Payload (with 5-foot ground resolution)
- E-6—General Area Coverage, Recoverable Payload (with at least 20-foot ground resolution)

Payloads

E-1 Payloads—Checkout and testing of the E-1 payload are progressing satisfactorily at Vandenberg Air Force Base.

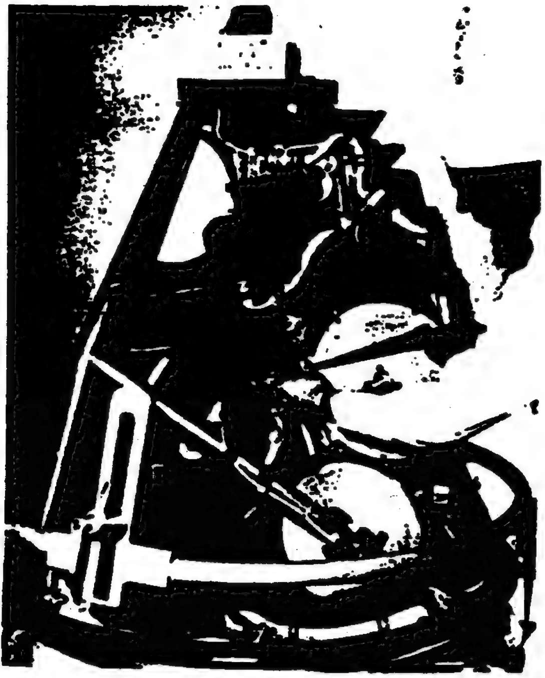


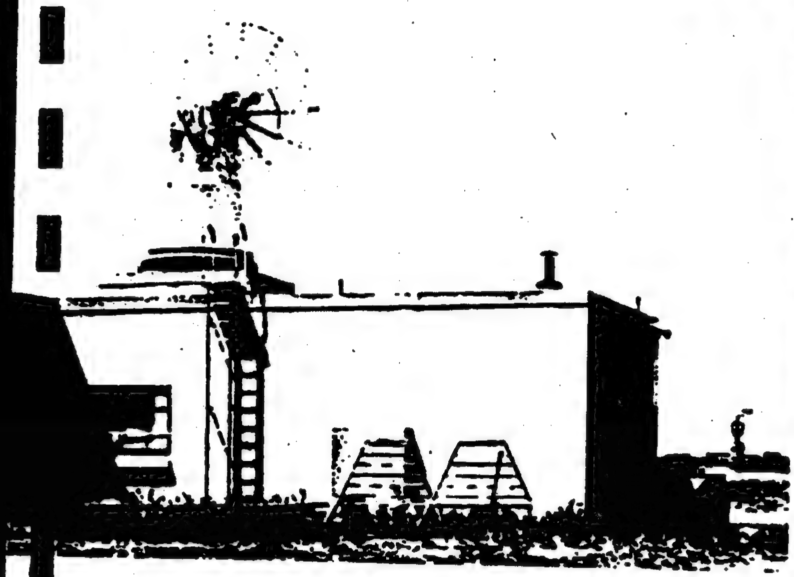
Figure 7. E-1 payload for first SAMOS flight showing technician installing pre-exposed, predeveloped film prior to testing the payload readout phase of operation.

E-2 Payloads—Initial E-2 payload component testing and assembly is progressing satisfactorily at Eastman Kodak. All components for the first flight payload (to be carried on the fourth SAMOS flight) are assembled and component qualification tests are underway prior to final payload assembly. Environmental tests of the thermal mock-up in the high altitude temperature simulator indicate that successful environmental control of critical components can be achieved under both hot and cold orbital conditions.

E-5 Payload—Development of the E-5 recovery payload continues on schedule. Design releases for the full-scale test models are nearing completion and fabrication of the initial test capsules is in progress. Wind tunnel tests of the aerodynamic configuration have been completed, except for the shock tunnel tests now being conducted at Cornell Aeronautical Laboratories. Aerodynamic/thermodynamic tests of the ablative heat shield are scheduled to begin at the Avco Corporation test facility in early August. A series of drop tests were initiated on 11 July at El Centro, California to evaluate the merits of a single large parachute and a cluster of three smaller parachutes to determine the most suitable configuration for capsule final descent. Tests to determine capsule drag and oscillation characteristics during retrieval into a recovery aircraft have started at Edwards Air Force Base.

Ground Support Equipment

- Delivery of major items of ground equipment to Vandenberg Air Force Base in support of the initial SAMOS flights is now complete. The electronics package for the visual reconnaissance payload vacuum test chamber was shipped to the missile assembly building on 20 July.
- Installation of the E-1 operating console, the second set of E-1/E-2 visual reconnaissance ground reconstruction electronics equipment, and two primary record cameras in the Vandenberg Air Force Base data acquisition and processing building were completed during the report period. Installation of the UHF equipment required for initial SAMOS operations at the Vandenberg Air Force Base tracking and acquisition station is complete, and the equipment is undergoing systems integration. Also completed was the installation of the Model 1604 computer.
- Assembly and checkout of the Programmable Integrated Control Equipment (PICE), to be available for the third and subsequent SAMOS flights, are



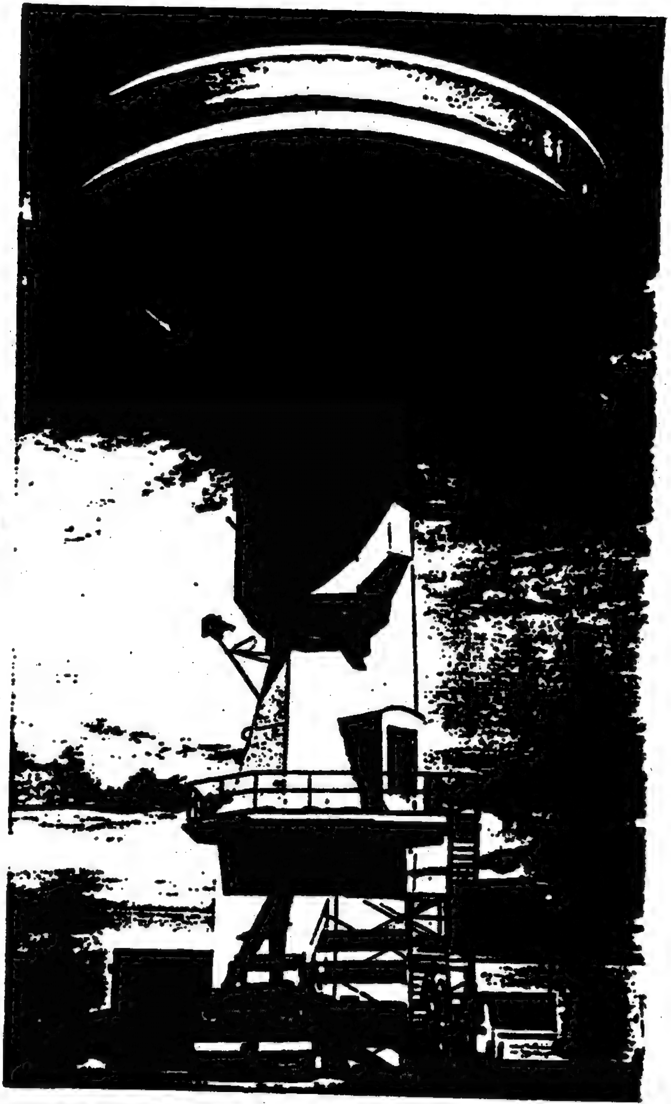
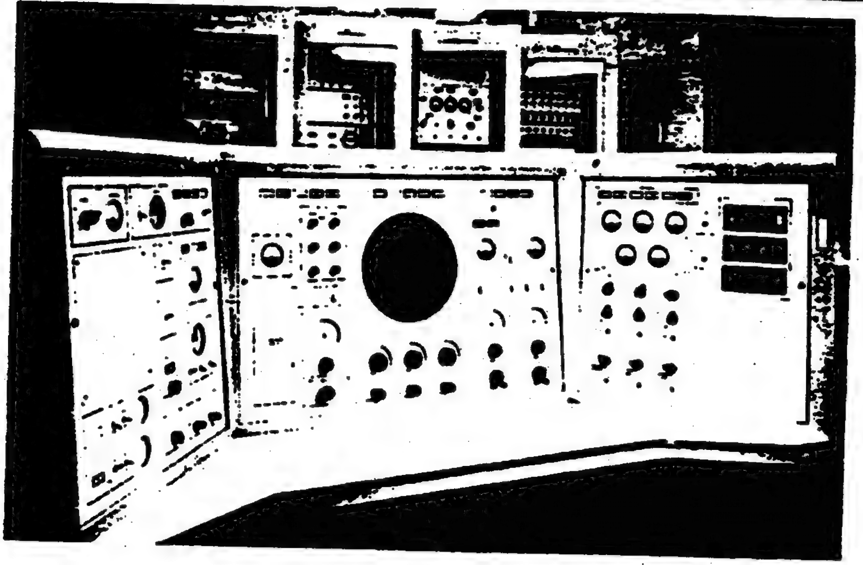


Figure 8. Aerial view (opposite page, lower) of the Vandenberg Air Force Base tracking and data acquisition station. The TLM-18 VHF antenna is in the upper left of the picture and the 60-foot telemetry and data antenna is in the lower right. UHF angle tracking antenna and control building (above) at Vandenberg Air Force Base. Sixty-foot antenna is in the background. Closeup (right) of the 60-foot UHF tracking and data antenna. Angle tracker console, (below) with equipment racks in the background. This equipment is undergoing systems integration tests.



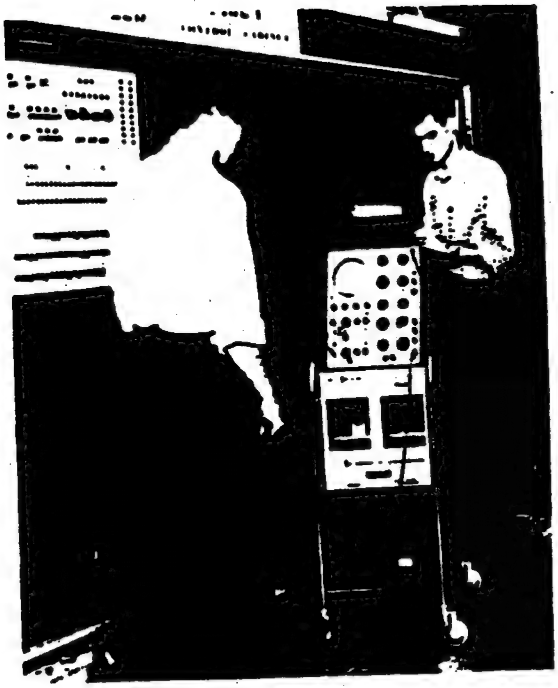


Figure 9. Checking Programmable Integrated Control Equipment (PICE) control cabinet operation. The first set is scheduled for installation at Vandenberg Air Force Base in September.

progressing on schedule at the contractors facility. Functional checkout and compatibility tests of set No. 1 are now in progress. Delivery to the Vandenberg Air Force Base tracking and acquisition station is scheduled for September. Set No. 2, scheduled for delivery to the Satellite Test Center 60 days after completion of Set No. 1, is in final assembly.

Ferret Reconnaissance System

- Ferret Reconnaissance System payloads are being developed in a minimum number of configurations. The designation and purpose of each configuration is as follows:

F-1—Component Test Payloads

F-2—Digital General Coverage Payloads

F-3—Specific Mission Payloads—Analog Presentation

Payloads

F-1 Payloads—The F-1 payload, previously deleted from the first SAMOS flight, was reinstated on 26 July. Checkout and testing of the payload has been accelerated at Vandenberg Air Force Base.

Ground Support Equipment

- The F-1 operating console has been delivered to the data acquisition and processing building at Vandenberg Air Force Base.

Facilities

- Construction of all facilities required for the first SAMOS flight is complete, and installation and checkout of equipment are progressing at a rate compatible with the scheduled launch date. Systems testing of the Pad 1 complex at Point Arguello was completed late in July.
- Bid opening for the Point Arguello diesel generator building was held on 26 July. A total of twelve bids ranging from $184,000 to $249,000 were received.
- The SAMOS laboratory building at Vandenberg Air Force Base was completed and accepted on 18 July, with minor deficiencies remaining to be corrected. Design of the Vandenberg Air Force Base helium unloading and storage facility has been initiated with design completion scheduled in early October.

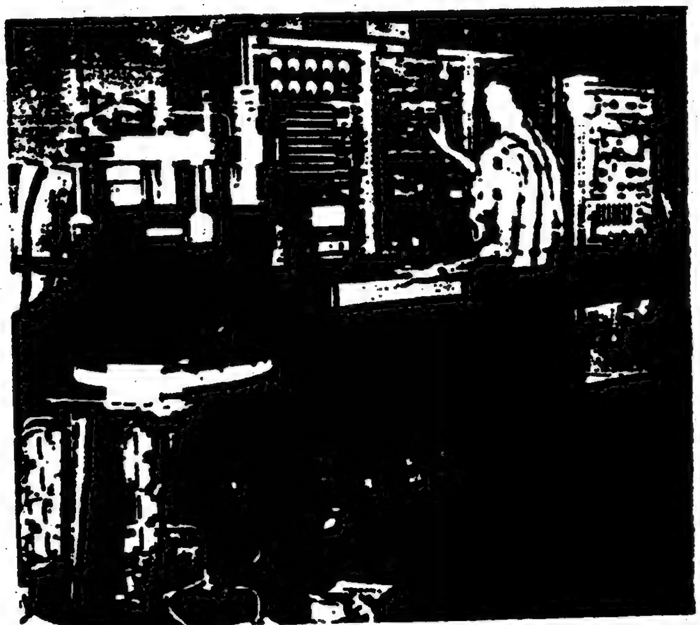


Figure 10. Adjusting the checkout console signal generator during functional testing of the F-1 payload. These tests consist of checking payload readout against calibrated inputs. The telemetry monitoring equipment is in the left-hand section of the console.

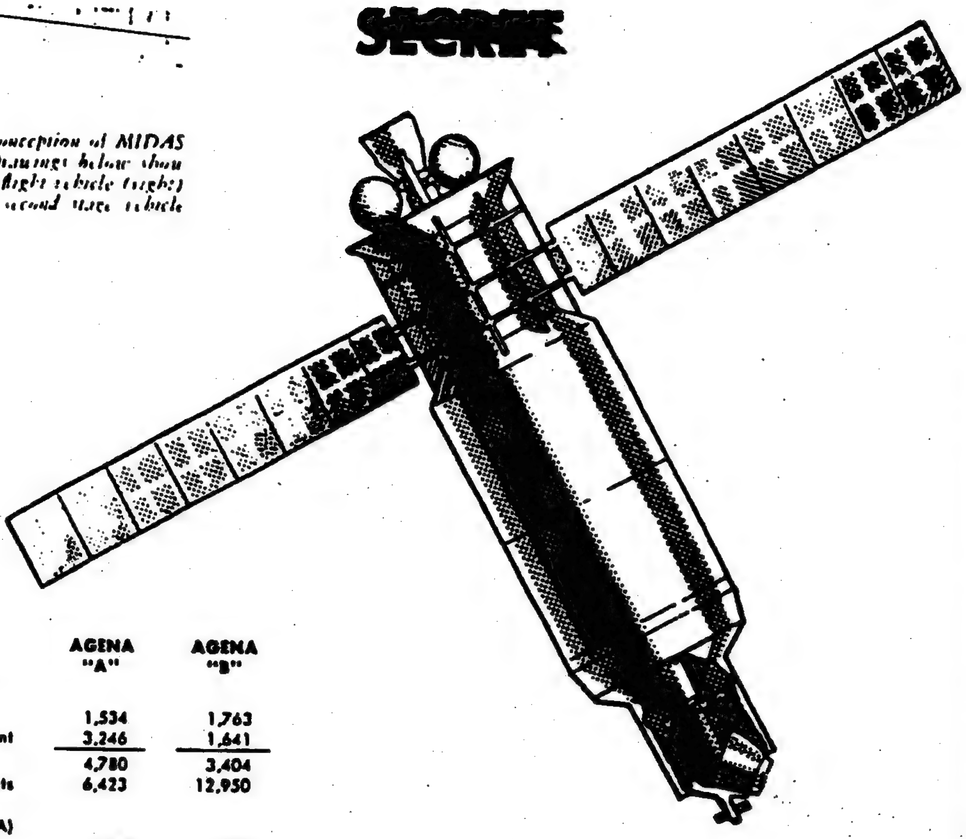
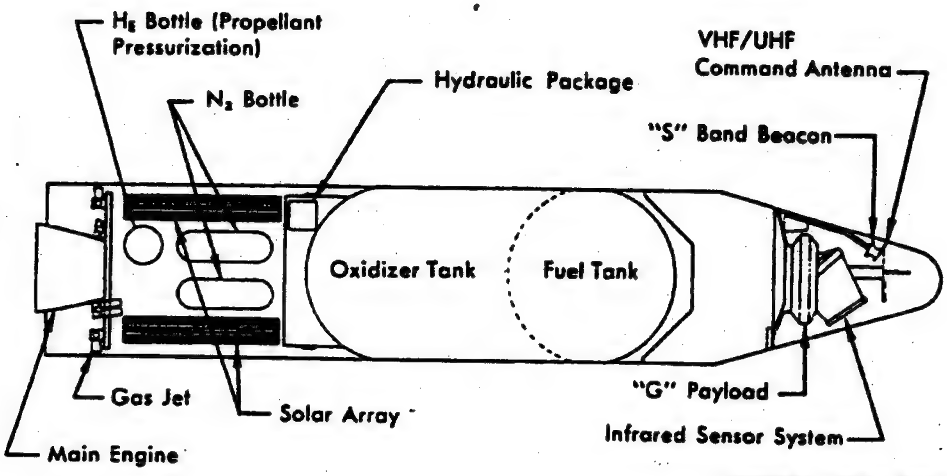


Figure 1. Artist's conception of MIDAS satellite (right). Drawings below show complete two-stage flight vehicle (right) and AGENA "B" second stage vehicle (left).

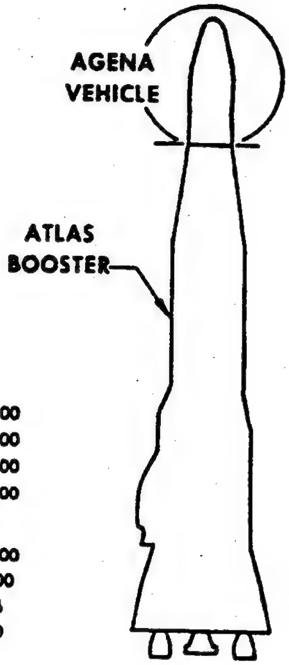
M
i
d
a
s

SECOND STAGE	**AGENA "A"**	**AGENA "B"**
Weight—		
Inert	1,534	1,763
Payload equipment	3,246	1,641
Orbital	4,780	3,404
Impulse Propellants	6,423	12,950
Fuel (UDMH)		
Oxidizer (IRFNA)		
Other	606	758
GROSS WEIGHT (lbs.)	11,809	17,112
Engine	YLR81-Ba-5	XLR81-Ba-9
Thrust, lbs. (vac.)	15,600	16,000
Spec. Imp., sec. (vac.)	277	290
Burn Time, sec.	120	240
Restart Provisions	No	Yes



MIDAS, Configuration II, AGENA "B" Satellite

BOOSTER—ATLAS ICBM	
Weight—Wet	15,100
Fuel, RP-1	74,900
Oxidizer (LOX)	172,300
GROSS WEIGHT (lbs.)	262,300
Engine—MA-2	
Thrust (lbs. vac.) Boost	356,000
Sustainer	82,100
Spec. Imp. (sec. vac.) Boost	286
Sustainer	310



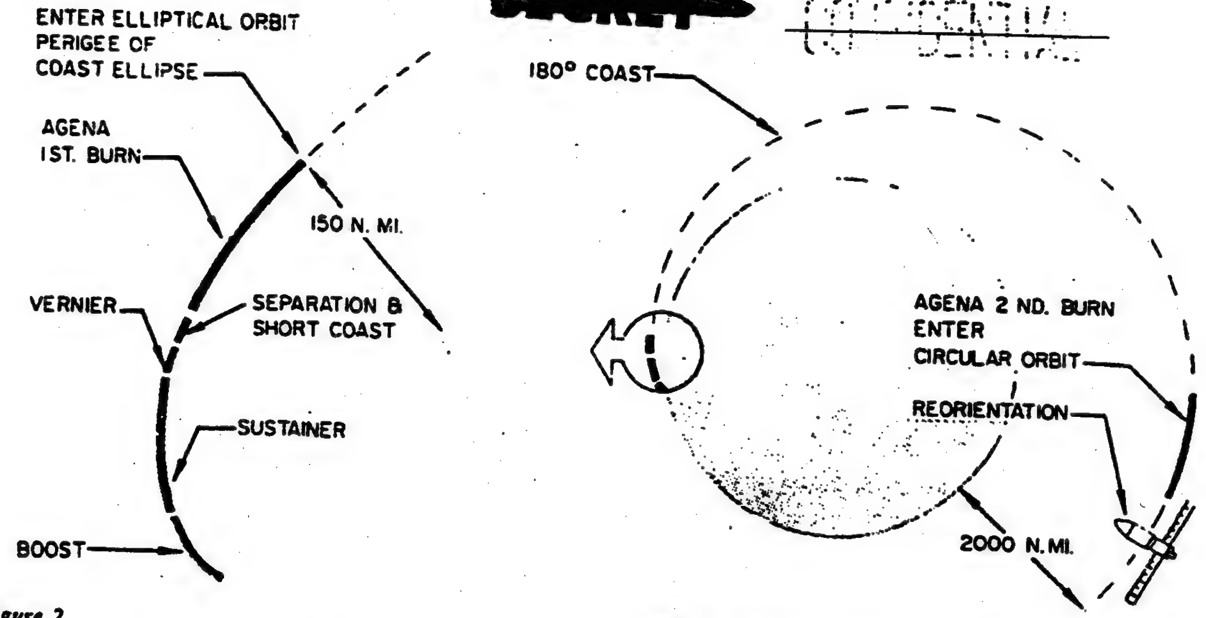


Figure 2.
Launch-to-orbit trajectory for flights 3 and subsequent. Optimum ATLAS boost, guided by radio-inertial system. AGENA ascent (coast, burn, coast, second burn) provides attitude reference. Also governs velocity magnitude and direction by inertial guidance system monitored by horizon scanner. Orbital attitude maintained by reaction wheel and gas jets.

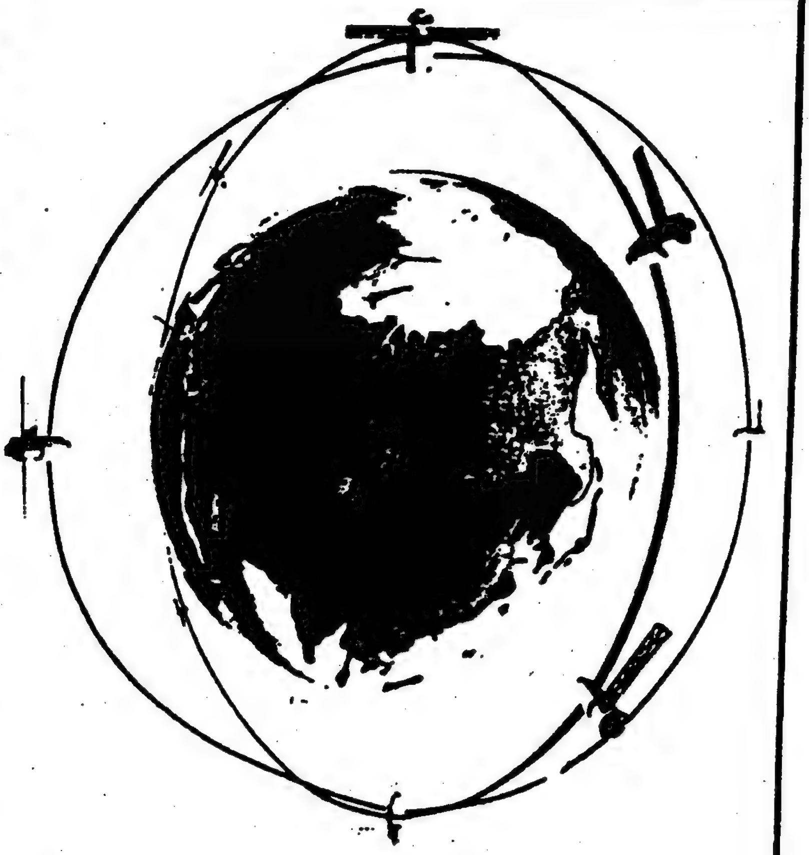


Figure 3.
Proposed MIDAS system. Four satellites spaced equidistant in each of two orthogonal planes at 2,000 n.m. altitude. Provides maximum coverage of USSR with minimum number of satellites.

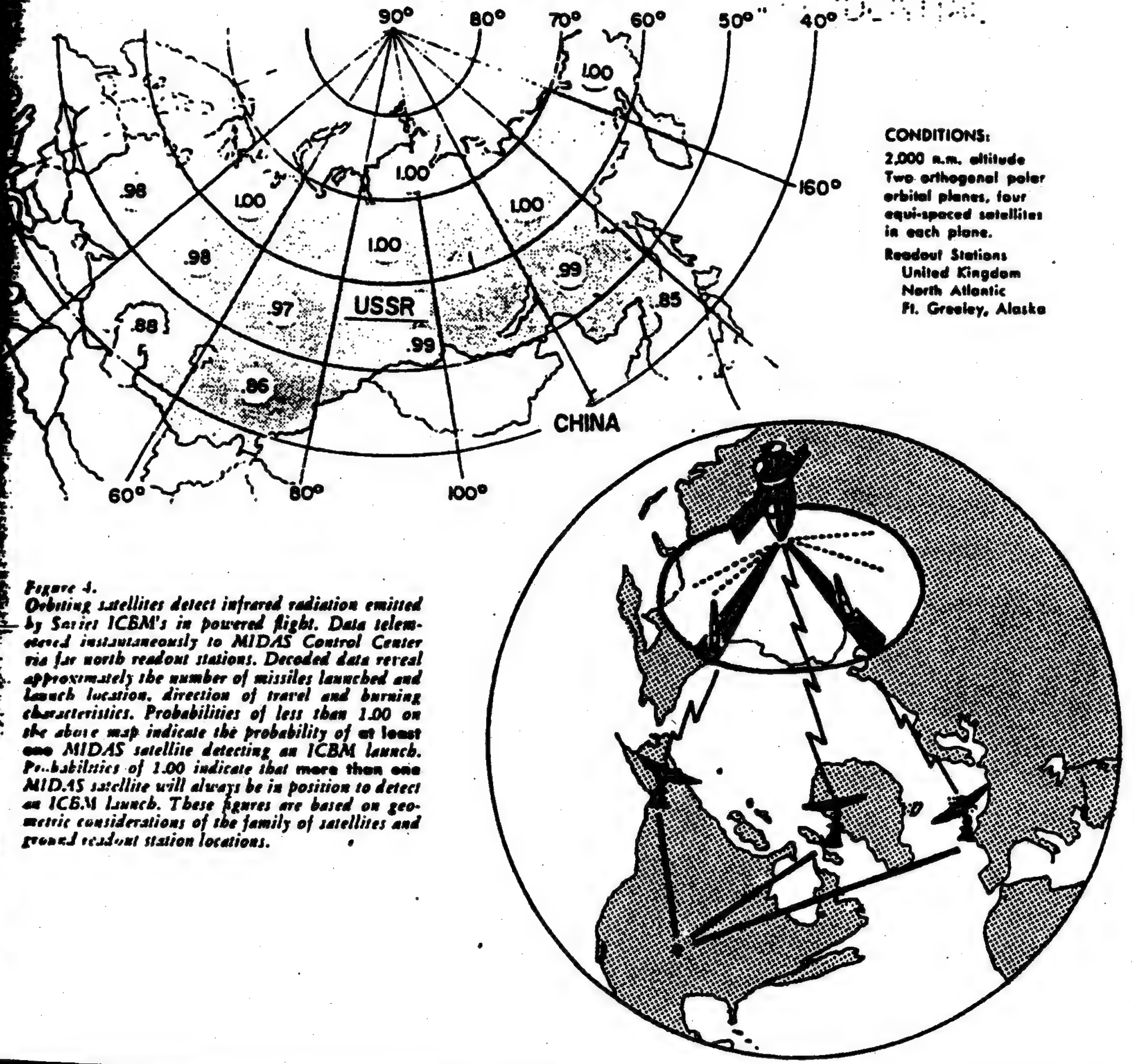
PROGRAM HISTORY

The MIDAS Program was included in Weapon System 117L when WS 117L was transferred to the Advanced Research Projects Agency. ARPA subsequently separated WS 117L into the DISCOVERER, SAMOS and MIDAS Programs, with the MIDAS objectives based on an infrared reconnaissance system. The MIDAS (Missile Defense Alarm System) Program was directed by ARPA Order No. 38, dated 5 November 1958 until transferred to the Air Force on 17 November 1959. A ten launch development plan for MIDAS (WS-239A) has been approved. This R&D Program should make possible the achievement of an operational system by 1963.

[redacted]

nitud
by h
whe

Weap
ansferre
: Agency
117L int
DAS Pro
based o
tem. The
tem) Pro-
r No. 38
sferred t
59. A te
AS (WS-
Program
ent of a



CONDITIONS:
2,000 n.m. altitude
Two orthogonal polar orbital planes, four equi-spaced satellites in each plane.
Readout Stations
United Kingdom
North Atlantic
Ft. Greeley, Alaska

Figure 4.
Orbiting satellites detect infrared radiation emitted by Soviet ICBM's in powered flight. Data telemetered instantaneously to MIDAS Control Center via far north readout stations. Decoded data reveal approximately the number of missiles launched and launch location, direction of travel and burning characteristics. Probabilities of less than 1.00 on the above map indicate the probability of at least one MIDAS satellite detecting an ICBM launch. Probabilities of 1.00 indicate that more than one MIDAS satellite will always be in position to detect an ICBM launch. These figures are based on geometric considerations of the family of satellites and ground readout station locations.

TECHNICAL HISTORY

The MIDAS infrared reconnaissance payload is engineered to use a standard launch vehicle configuration. This consists of an ATLAS missile as the first stage and the AGENA vehicle, powered by a Bell Aircraft rocket engine as the second, orbiting stage (Figure 1). The total payload weight is approximately 1,000 pounds.

The first two of the ten R&D flights used the AGENA "A" and ATLAS "D" vehicle programmed to place the payload in a circular 261 nautical mile orbit. Subsequent R&D flights will utilize the ATLAS "D"/AGENA "B" configuration which will be programmed to place the payload in a circular 2,000 nautical mile polar orbit.

MIDAS I, launched in February 1960, did not attain orbit because of a failure during ATLAS/AGENA separation.

MIDAS II, launched in May 1960, was highly successful. Performance with respect to programmed orbital parameters was outstanding. Useful infrared data were observed and recorded.

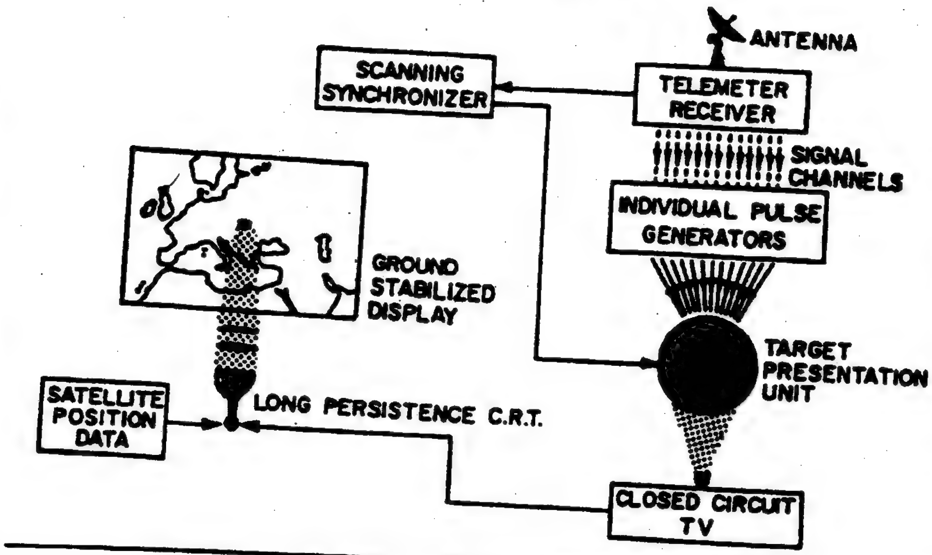
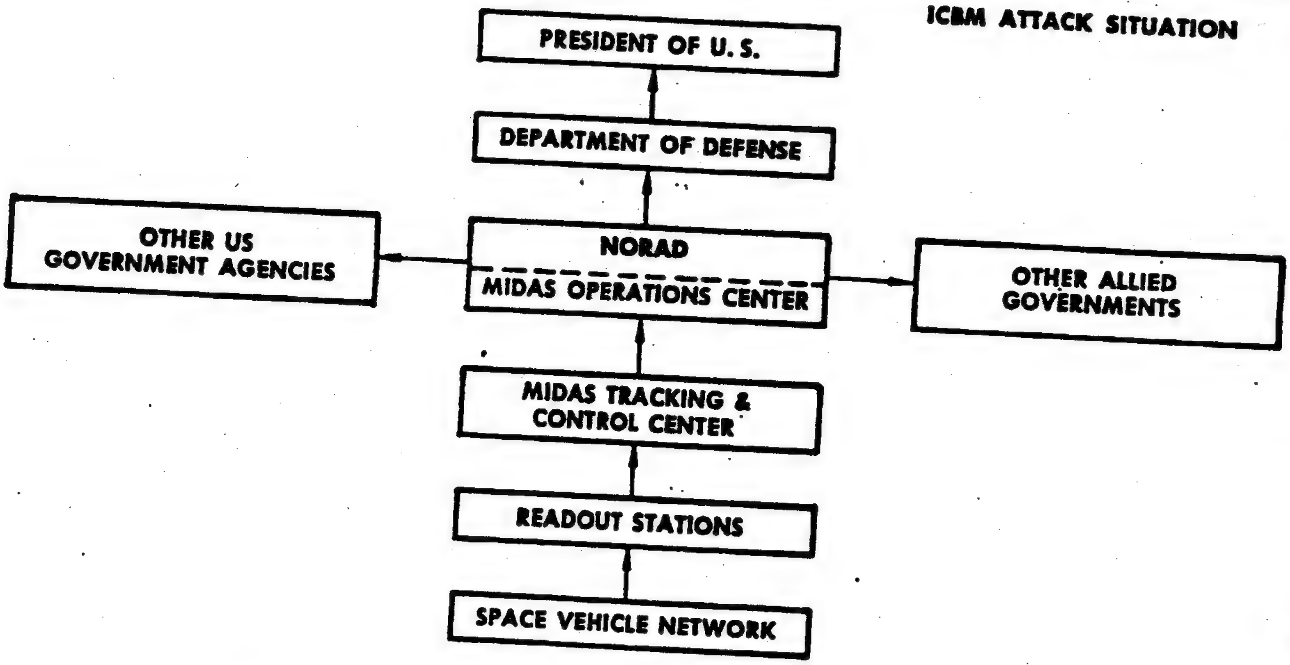
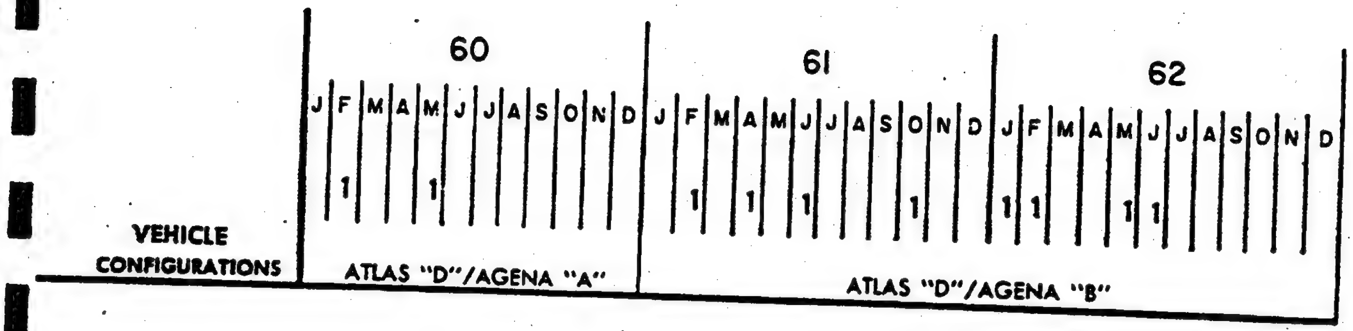


Figure 5. Simplified version of ground presentation system (left) for display of infrared reconnaissance data. The data is displayed on a TV monitor with a map overlay. The chart below shows data flow from the readout stations to decision-making agencies. The MIDAS Control Center, or other using agencies having a correlated ground stabilized display, can determine when an actual attack has been launched.



CONCEPT

The MIDAS system is designed to provide continuous infrared reconnaissance of the Soviet Union. Surveillance will be conducted by eight satellite vehicles in accurately positioned orbits (Figure 3). The area under surveillance must be in line-of-sight view of the scanning satellite. Mission capabilities are shown in Figure 4. The system is designed to accomplish instantaneous readout of acquired data by at least one of three strategically located readout stations. The readout stations transmit the data directly to the MIDAS Control Center where it is processed, displayed, and evaluated (Figure 5.) If an attack is determined to be underway, the intelligence is communicated to a central Department of Defense Command Post for relay to the President and all national retaliatory and defense agencies.



MIDAS Launch Schedule

Monthly Progress—MIDAS Program

Program Administration

- The Air Force Ballistic Missile Committee has authorized two additional MIDAS flights, designated RM-1 and RM-2. These flights will be THOR-boosted and will use AGENA "B" vehicles currently in the DISCOVERER Program. A background radiometer will be carried rather than an infrared missile detection payload. These flights will provide infrared background measurements for a wide variety of conditions, as may exist between arctic and tropical regions. They will assist in determining the magnitude of background radiance in the 2.7 and 4.3 micron absorption range and in establishing the spatial and spectral background characteristics which must be known for current as well as future MIDAS requirements.

Figure 6. MIDAS ground presentation console installed in the Vandenberg Air Force Base blockhouse.

Technical Progress

Second Stage Vehicles

- Assembly of the AGENA "B" vehicle for the third MIDAS flight is proceeding on schedule. Delivery to the systems test area is scheduled for 3 August. This is the first MIDAS vehicle to have restart capability.

- Because of the recent strike, a schedule slippage has been incurred in the fabrication phase of the two subsequent AGENA "B" flight vehicles. The impact of these schedule slippages is not well defined at this time.

Infrared Scanner Units

Infrared scanner units for flights 3, 4 and 5 are being manufactured by Baird-Atomic, Inc. and for flights 6, 7, and 8 by Aerojet-General Corporation.

- Production and organizational changes directed toward achieving the desired production quality and delivery rate have been instituted at Baird-Atomic, Inc. A reevaluation of their infrared delivery schedule has established 29 August as the delivery date for the initial flight unit. Five flight payloads are scheduled for delivery.

- Should the results of acceptance testing indicate the desirability of replacing the drive motors or the turret bearing, larger drive motors have been ordered and a new bearing is being designed.

- A detailed reliability test program is being developed for the Aerojet-General advanced infrared detection payload configuration. In addition to developing the service test model of this payload, Aerojet is now contracted to procure long-leadtime items for the flight payloads. The definitive contract for this payload is expected to be completed in August.

Facilities

United Kingdom Station—Government-to-government agreement is being drafted for this station in anticipation of approval of the MIDAS operational program. Facility design criteria applicable to this and other MIDAS readout stations are being prepared.

Southeast Africa Station—A site survey team is scheduled to depart for the Union of South Africa during the first week in August to conduct site surveys for the Southeast Africa telemetry station.

North Pacific Station—Construction of the Donnelly Flats, Alaska, technical facilities is proceeding on schedule. Because of last year's prolonged steel strike and the late thaw this spring, construction of the support facilities at Fort Greely, Alaska, will be delayed approximately two months. Completion is now scheduled for December.

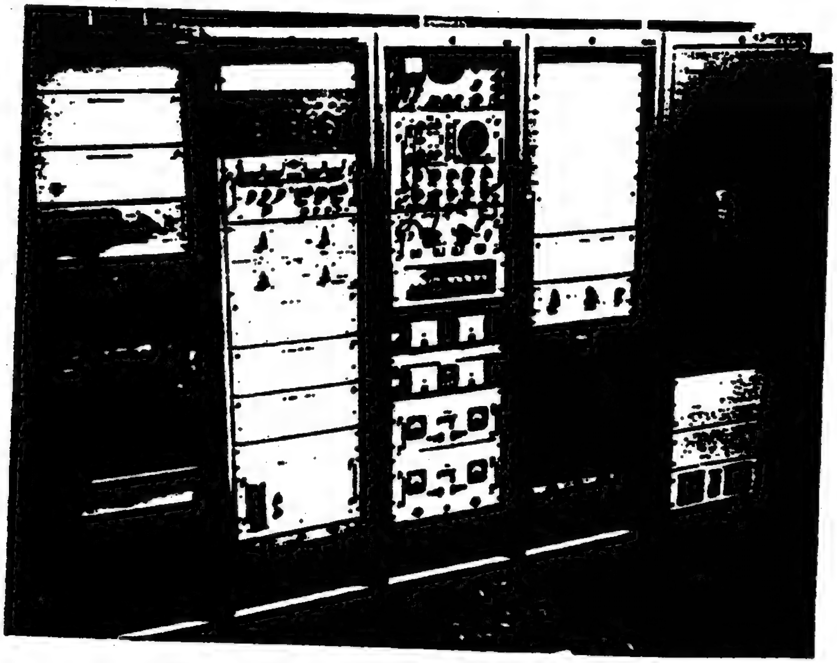


Figure 7. MIDAS data processing equipment installed at the Satellite Test Center.

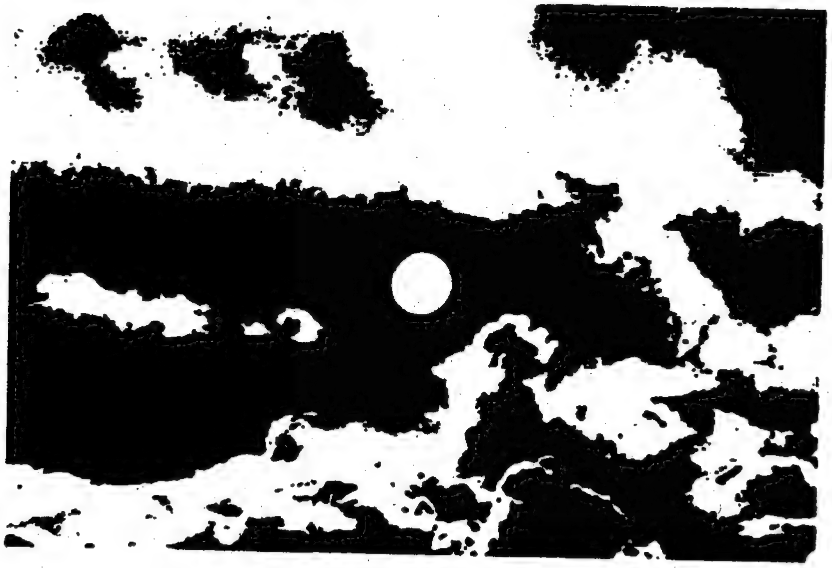
AFBMD Activities in Space, Aug 60

(Hq cy)

[redacted]

SATELLITE

systems



DISCOVERER
SAMOS
MIDAS
COMMUNICATIONS
SATELLITE

SATELLITE SYSTEMS

Discoverer

The DISCOVERER Program consists of the design, development and flight testing of 37 two-stage vehicles, using the THOR IRBM as the first stage booster and the AGENA as the second stage, satellite vehicle. The program was established early in 1958 under direction of the Advanced Research Project's Agency, with technical management assigned to AFBMD. On 14 November 1959, program responsibility was transferred from ARPA to the Air Force by the Secretary of Defense. Prime contractor for the program is Lockheed Missile and Space Division. The DISCOVERER Program will perform space research in support of the advanced military reconnaissance satellite programs.

PROGRAM OBJECTIVES

(a) Flight test of the satellite vehicle airframe, propulsion, guidance and control systems, auxiliary power supply, and telemetry, tracking and command equipment.

(b) Attaining satellite stabilization in orbit.

(c) Obtaining satellite internal thermal environment data.

(d) Testing of techniques for recovery of a capsule ejected from the orbiting satellite.

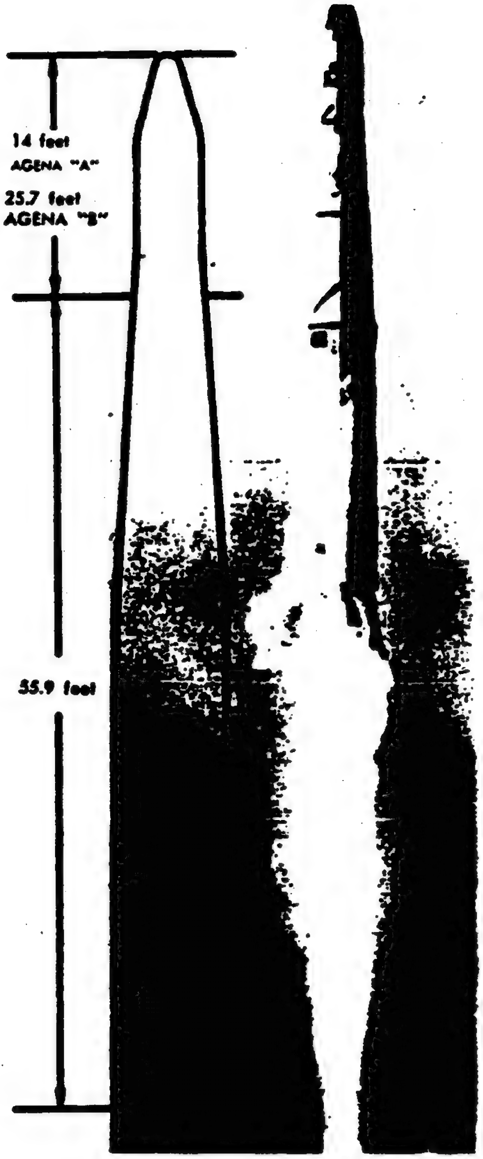
(e) Testing of ground support equipment and development of personnel proficiency.

(f) Conducting bio-medical experiments with mice and small primates, including injection into orbit, re-entry and recovery.

PROGRAM SUMMARY

Early launches confirmed vehicle flight and satellite orbit capabilities, developed system reliability, and established ground support, tracking and data acquisition requirements. Later in the program, biomedical and advanced engineering payloads will be flight tested to obtain support data for more advanced space systems programs. DISCOVERER vehicles are launched from Vandenberg Air Force Base, with overall operational control exercised by the Satellite Test Center, Palo Alto, California.

Tracking and command functions are performed by the stations listed in the Table on page A-4. A history of DISCOVERER flight to date is given on page A-5.



SECOND STAGE	AGENA "A"	AGENA "B"	
Weight—			
Inert	1,262	1,328	1,346
Payload equipment	497	887	915
Orbital	1,759	2,215	2,216
Impulse propellants	6,525	12,950	12,950
Other	378	511	511
TOTAL WEIGHT	8,662	15,676	15,722
Engine Model	YLR81-Ba-5	XLR81-Ba-7	XLR81-Ba-9
Thrust-lbs., vac.	15,600	15,600	16,000
Spec. Imp.-sec., vac.	277	277	290
Burn time-sec.	120	240	240
THOR BOOSTER		DM-18	DM-21
Weight—Dry		6,950	6,500
Fuel		33,700	33,700
Oxidizer (LOX)		68,200	68,200
GROSS WEIGHT (lbs.)		108,850	108,400
Engine		MB-3 Block 1	MB-3 Block 2
Thrust, lbs. (S.L.)		152,000	167,000
Spec. Imp., sec. (S.L.)		247.8	248.3
Burn Time, sec.		163	148

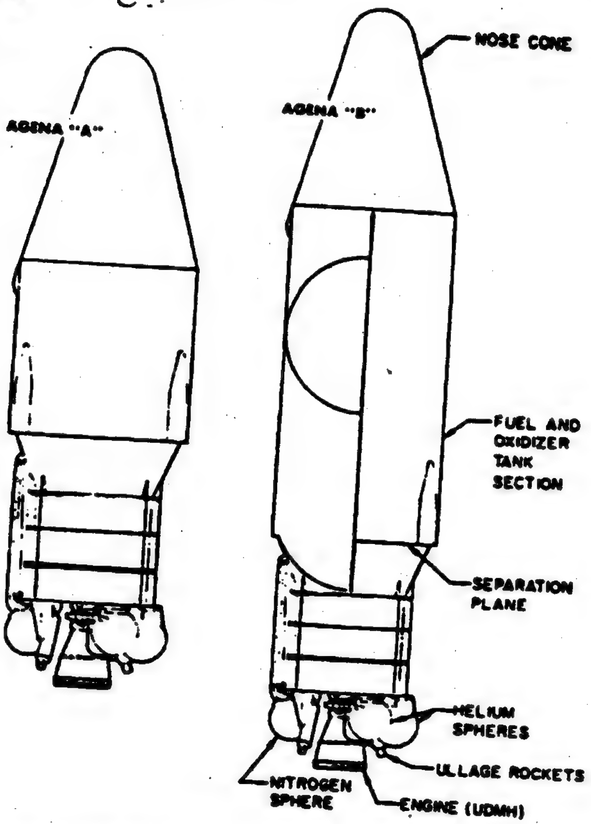
Telemetry ships are positioned as required by the specific mission of each flight. Figures 2 and 3 show a typical launch trajectory from Vandenberg Air Force Base, and figure 3 shows schematically a typical orbit. An additional objective of this program is the development of a controlled re-entry and recovery capability for the payload capsule (Figure 4). An impact area has been established near the Hawaiian Islands, and a recovery force activated. Techniques have been developed for aerial recovery by C-119 aircraft and for sea recovery by Navy surface vessels. The recovery phase of the program has provided advances in re-entry vehicle technology. This information will be used in support of more advanced projects, including the return of a manned satellite from orbit.

FLIGHT VEHICLE

The three versions of flight test vehicles used in the DISCOVERER Program are defined in the launch schedule shown on page A-5. Specifications for the two THOR configurations and three AGENA configurations used are given on page A-1.

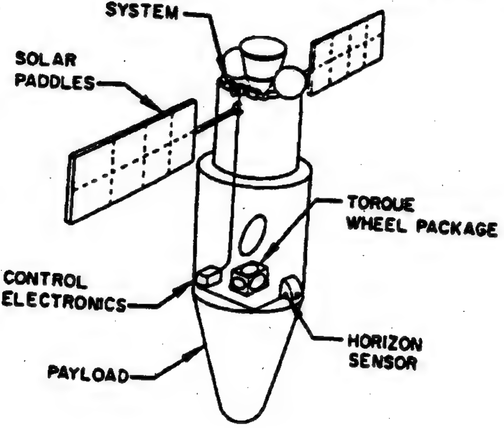
AGENA VEHICLE DEVELOPMENT

The AGENA vehicle was originally designed by the Air Force as the basic satellite vehicle for Advanced Military Reconnaissance Satellite Systems Programs. Basic design was based on use of the ATLAS ICBM as the first stage. ATLAS trajectory characteristics and the stringent eccentricity requirements of the advanced programs led to the selection of a guidance system suited to achieving orbital injection in a horizontal attitude. As a result, an optical inertial system was developed for vehicle guidance and a gas jet system for orbital attitude control. An urgent need for attaining higher altitude orbits resulted in development of the AGENA "B" versions. The YLR81 Ba-5 version of the LR81-Ba-3 engine (Bell Hustler engine developed for B-58 aircraft) is used on AGENA "A" vehicles. The YLR81-Ba-5 version of this engine was developed to provide increased performance through the use of unsymmetrical di-methyl hydrazine (UDMH) fuel instead of JP-4.



Early AGENA "B" vehicles will use the YLR81-Ba-7 version of this engine. The majority of AGENA "B" vehicles will use the XLR81-Ba-9 engine incorporating a nozzle expansion ratio of 45:1, and providing a further increase in performance capability including engine restart and extended burn-capability.

SAMOS and MIDAS AGENA VEHICLE

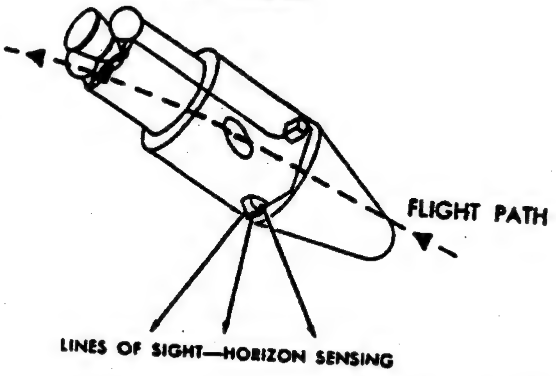


PERFORMANCE CAPABILITIES

ALTITUDE
200–20,000 MILES

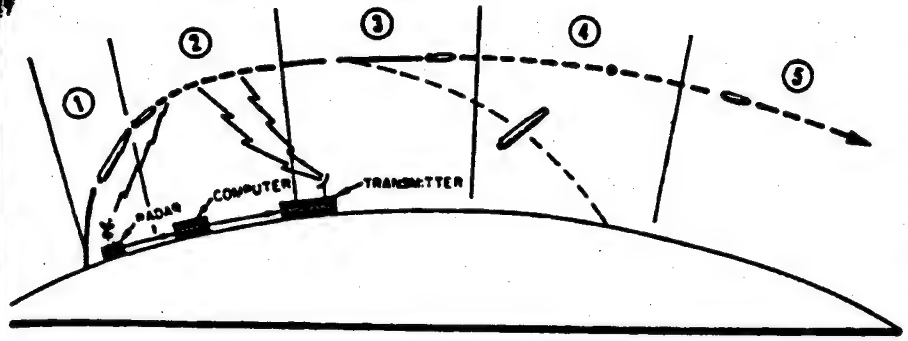
ATTITUDE
ROLL – 0.1 DEGREE
PITCH – 0.1 DEGREE
YAW – 1 DEGREE

DISCOVERER/AGENA

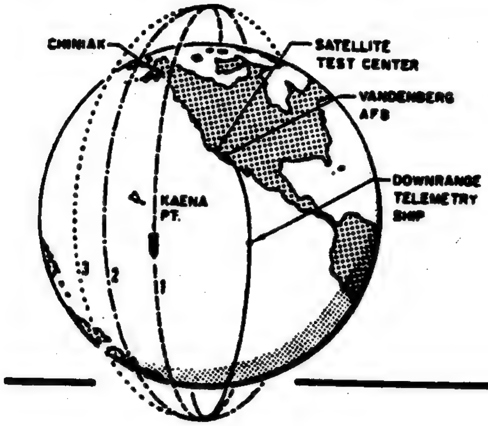


LINES OF SIGHT—HORIZON SENSING

Powered Flight Trajectory



1. First Stage Powered Flight—2.5 minutes duration, 78 n.m. downrange, guided by programmed auto pilot.
2. Coast Period—2.4 minutes duration, to 380 n.m. downrange; altitude controlled by inertial reference package, horizon scanner, gas reaction jets. Receives AGENA time to fire and velocity to be gained commands.
3. Second Stage Powered Flight—2 minutes duration, to 770 n.m. downrange. Guided and controlled by inertial reference package, horizon scanner, gas reaction jets (roll) gimballing engine, yaw and pitch accelerometer—integrated.
4. Vehicle Reorients to Nose Aft—2 minutes duration, to 2,000 n.m. downrange. Guided and attitude controlled by inertial reference package, horizon scanner and gas reaction jets.
5. In-Orbit—Controlled (same as 4).

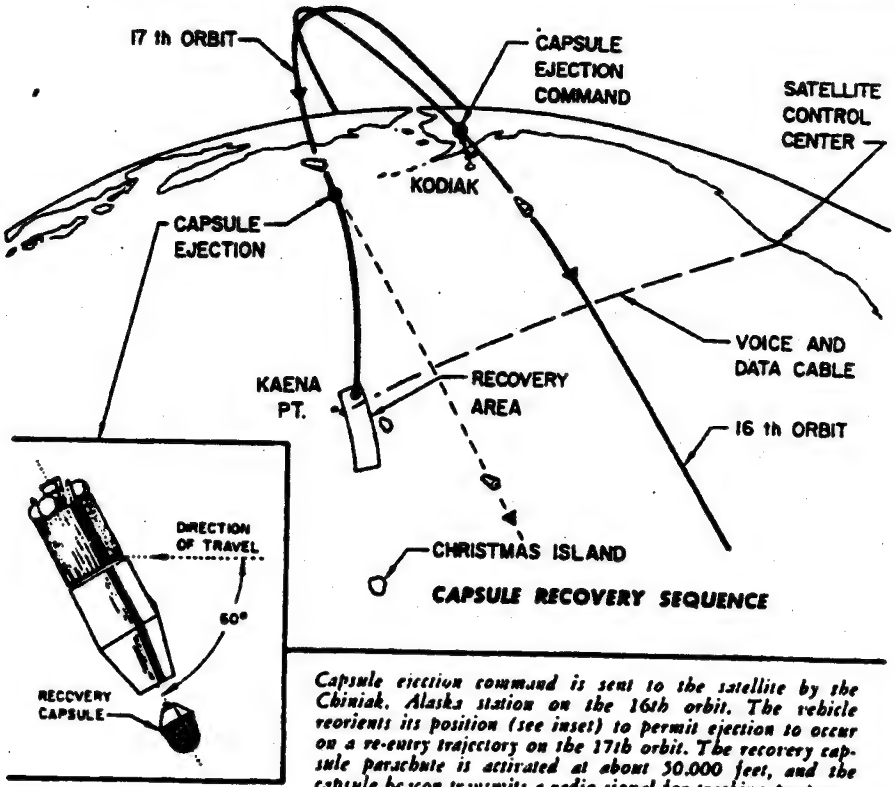


Orbital Trajectory

Schematic presentation of orbital trajectory following launch from Vandenberg Air Force Base. Functions performed by each station and a listing of equipment used by each station, is given on page A-4.

RECOVERY CAPABILITY

This objective was added to the program after the first launch achieved vehicle flight and orbit objectives successfully. It includes the orientation of the satellite vehicle to permit a recoverable capsule to be ejected from the nose section of the AGENA vehicle. Ejection is programmed to occur on command on the 17th orbit, for capsule impact within the predetermined recovery area south of Hawaii. Aircraft and surface vessels are deployed within the area as a recovery force.



CAPSULE RECOVERY SEQUENCE

Capsule ejection command is sent to the satellite by the Chiniak, Alaska station on the 16th orbit. The vehicle reorients its position (see inset) to permit ejection to occur on a re-entry trajectory on the 17th orbit. The recovery capsule parachute is activated at about 50,000 feet, and the capsule beacon transmits a radio signal for tracking purposes. The recovery force is deployed in the recovery (impact) area.

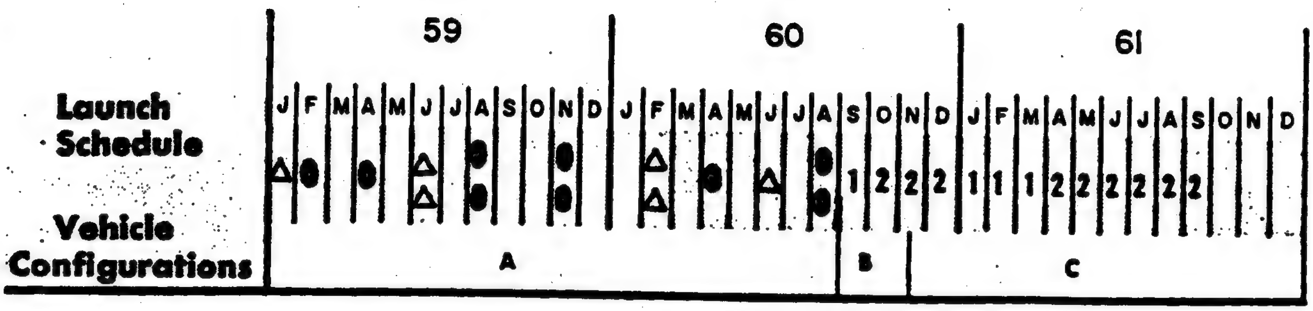
ONE
L AND
DIZER
K
TION
RATION
E
ES
ROCKETS
H)
nt
n
1
er
n
is
n-
ly
7
g
a
g
PATH
4-4-234

Facility	Equipment*	Flight Function
Satellite Test Center	A	Over-all control, convert tracking stations data to obtain a predicted orbit and generate subsequent ephemerides issue acquisition data to tracking stations for subsequent passes, predict recovery area.
Vandenberg AFB	BCDEFGHIJK	Launch, ascent and orbital tracking, telemetry reception, trajectory measurements including time to ignite second stage.
Point Mugu	BCDEFGHIJKL	Ascent tracking and telemetry data reception, transmits command to ignite and shut down AGENA (via guidance computer).
Telemetry Ship (Pvt. Joe E. Mann)	DF	Final stage ascent tracking and telemetry data reception.
Kodiak, Alaska (tracking station)	BDEFGHIJK	Orbital tracking and telemetry data reception, including first pass acquisition, recovery capsule ejection and impact prediction.
Kaena Point, Oahu, Hawaii (tracking station)	BCDEFGHIJK	Orbital tracking and telemetry data reception.
Hickam AFB Oahu, Hawaii		Over-all direction of capsule recovery operations.

***Equipment**

A. 2 UNIVAC 1103-A digital computers
B. VERLORT (Modified Mod II) radar
C. TLM-18 self-tracking telemetering antenna
D. Tri-helix antenna
E. Doppler range detection equipment
F. Telemetry tape recording equipment
G. Telemetry decommutators for real time data presentation
H. Plot boards for radar and TLM-18 tracking data
I. Conversion equipment for teletype transmission of radar, TLM-18 and doppler tracking data in binary format
J. Acquisition programmer for pre-acquisition direction of antennas
K. Ground command to satellite transmission equipment
L. Guidance computer

GROUND SUPPORT FACILITIES



A. THOR—DM-18 / AGENA "A"

B. THOR—DM-21 MB-3 Block 1 / AGENA "B" XLR81-Ba-7

C. THOR—DM-21 MB-3 Block 2 / AGENA "B" XLR81-Ba-9

● Attained orbit successfully.

△ Failed to attain orbit.

Flight History

DISCOVERER No.	AGENA No.	THOR No.	Flight Date	Remarks
0	1019	160	21 January 1959	*AGENA destroyed by malfunction on pad. THOR refurbished for use on flight XII.*
I	1022	163	28 February	*Attained orbit successfully. Telemetry received for 514 seconds after lift-off.*
II	1018	170	13 April	*Attained orbit successfully. Recovery capsule ejected on 17th orbit was not recovered. All objectives except recovery successfully achieved.*
III	1020	174	3 June	*Launch, ascent, separation, coast and orbital boost successful. Failed to achieve orbit because of low performance of satellite engine.*
IV	1023	179	25 June	*Same as DISCOVERER III.*
V	1029	192	13 August	*All objectives successfully achieved except capsule recovery after ejection on 17th orbit.*
VI	1028	200	19 August	*Same as DISCOVERER V.*
VII	1051	206	7 November	*Attained orbit successfully. Lack of 400-cycle power prevented stabilization on orbit and recovery.*
VIII	1050	212	20 November	*Attained orbit successfully. Malfunction prevented AGENA engine shutdown at desired orbital velocity. Recovery capsule ejected but not recovered.*
IX	1052	218	4 February 1960	*THOR shut down prematurely. Umbilical cord mast did not retract. Quick disconnect failed, causing loss of helium pressure.*
X	1054	223	19 February	*THOR destroyed at T plus 56 sec. by Range Safety Officer.*
XI	1055	234	15 April	*Attained orbit successfully. Recovery capsule ejected on 17th orbit was not recovered. All objectives except recovery successfully achieved.*
XII	1053	160	29 June	*Launch, ascent, separation, coast and orbital stage ignition were successful. Failed to achieve orbit because of AGENA attitude during orbital stage boost.*
XIII	1057	231	10 August	*Attained orbit successfully. Recovery capsule ejected on 17th orbit. Capsule was recovered after a water impact with negligible damage All objectives except the airborne recovery were successfully achieved.*
XIV	1056	237	18 August	*Attained orbit successfully. Recovery capsule ejected on the 17th orbit and was successfully recovered by the airborne force. All objectives successfully achieved.*

MONTHLY PROGRESS—DISCOVERER Program

Progress

- During August a significant milestone was achieved in the DISCOVERER program when the data capsules of DISCOVERER XIII and XIV were ejected from the orbiting satellite, re-entered the earth's atmosphere and were recovered successfully within the programmed area north of the Hawaiian Islands. These two capsules represent the first objects to have been successfully recovered from an orbit in space. As such, they take their place among four other "firsts" achieved by the DISCOVERER program (see Table III).

DISCOVERER XIII

- DISCOVERER XIII was launched from Vandenberg Air Force Base at 13:38, PDT, on 10 August and was successfully injected into polar orbit. THOR booster trajectory was slightly high and west but was well within tolerance. Second stage separation was successfully accomplished as was transmission of Commands 5 (time-to-fire correction) and 6 (velocity-to-be-gained correction). AGENA performance was very close to nominal. Re-orientation of the satellite into a nose aft attitude was accomplished after burnout. Table I lists nominal and actual orbital parameters.

PARAMETER	NOMINAL	ACTUAL
Apogee, Statute Miles	408	429
Perigee, Statute Miles	140	155
Eccentricity	0.0323	0.0326
Period, Minimum	93.5	94.1
Inclination Angle, Degree	81.69	82.67
Injection, Altitude, Statute Miles	140	156
Injection Angle, Minimum	0	+0.08
Injection Velocity, ft/sec		25,852

TABLE I. DISCOVERER XIII Orbital Parameters

- The recovery sequence was automatically initiated by the satellite programmer 26 hours, 37 minutes after launch. This event occurred within range of the Kodiak, Alaska, tracking station as DISCOVERER XIII passed southward toward Hawaii on its

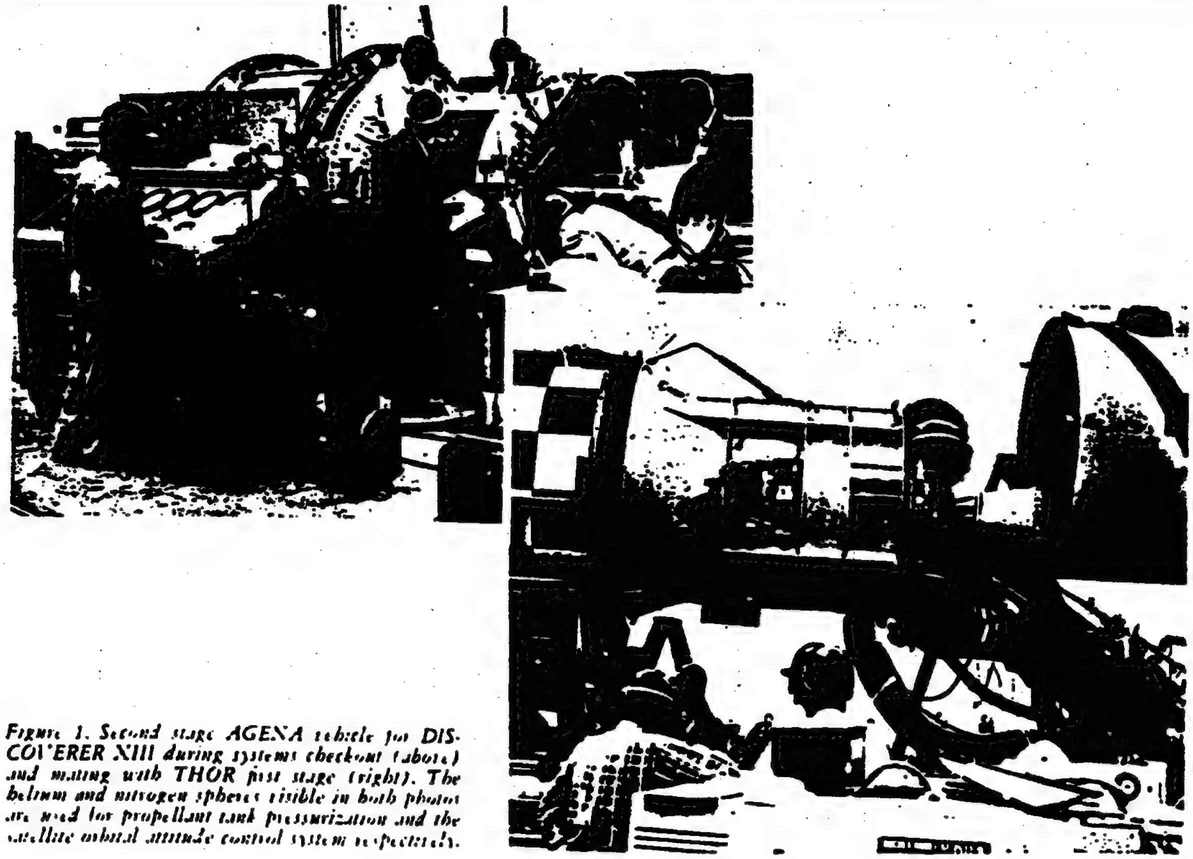


Figure 1. Second stage AGENA vehicle for DISCOVERER XIII during systems checkout (above) and mating with THOR first stage (right). The helium and nitrogen spheres visible in both photos are used for propellant tank pressurization and the satellite orbital attitude control system respectively.

17th orbit. Telemetry received by Kodiak from the satellite and the capsule confirmed that satellite pitchdown, capsule ejection, spin, retro rocket firing, capsule de-spin and thrust cone ejection were accomplished. Minutes later the Hawaiian tracking station acquired the telemetry signal and determined that ablative shield ejection and parachute deployment had occurred.

- All aircraft and ships of the recovery force within range acquired the capsule's RF beacon and began homing on the signal. No aircraft was able to attempt recovery, but one plane did observe the capsule impacting in the sea. A helicopter from the "Haiti Victory," one of the recovery ships, was sent to retrieve the capsule. The capsule was flown to Hawaii by helicopter, transferred to an Air Force plane, and delivered to Washington DC. After being viewed by President Eisenhower, the capsule was placed on public display by the Air Force. This historic object, the first man-made object recovered after a sustained period of orbit, will become part of the Smithsonian Institute's collection of space vehicles.

ion

- DISCOVERER XIII carried a diagnostic payload in addition to the normal recovery equipment. The payload contained instrumentation to determine capsule environment and the functioning of separation and recovery sequence events. A five channel telemetry system was installed to transmit the data obtained to the ground stations. To assure receipt of all data, a tape recorder was provided to record the real time events and capsule performance during the telemetry "blackout" period which occurs when the capsule re-enters the atmosphere. After a two-minute time delay, these stored data were transmitted to the ground stations. The high speed of re-entry induces ionization over the skin of the capsule which effectively blocks telemetry transmission. An S-band transponder was also provided to aid in tracking the capsule from ejection through recovery.

DISCOVERER XIV

- DISCOVERER XIV was launched at 1257, PDT, on 18 August into a polar orbit from Vandenberg Air Force Base. The launch was delayed approximately 15 minutes because the still orbiting DISCOVERER XIII satellite was passing through the projected flight area. THOR booster performance was near nominal. Separation, transmission of Commands 5 and 6, and orbital boost were accomplished as planned. Nominal and actual orbital parameters are given in Table II.

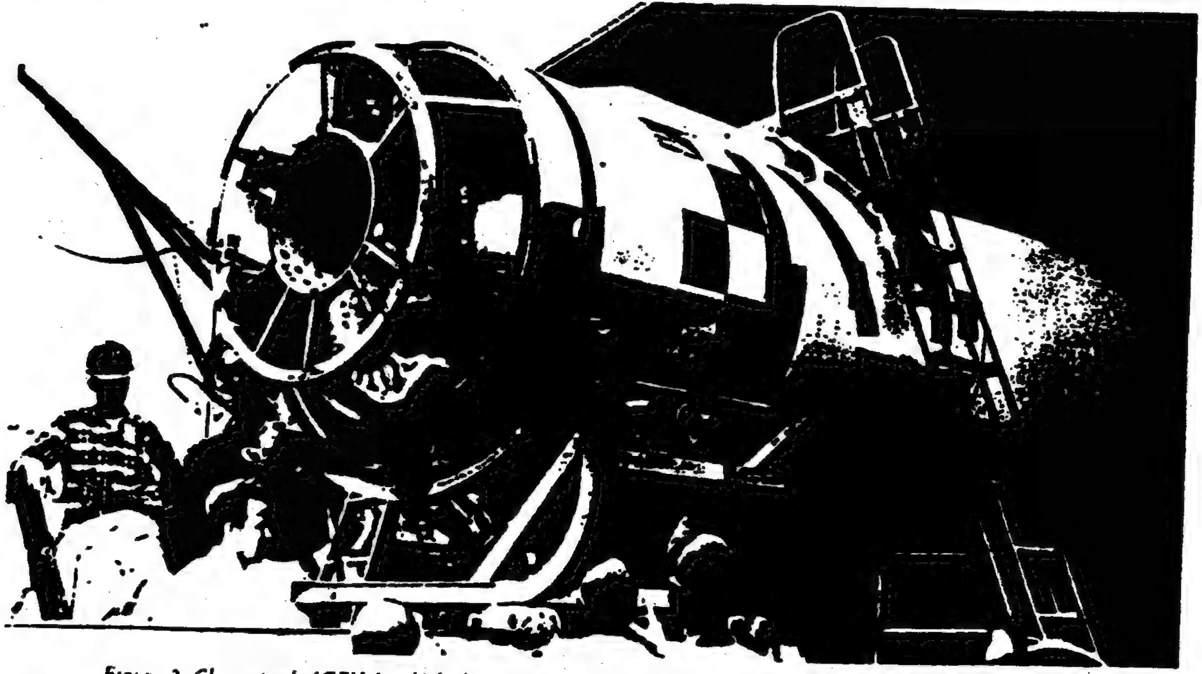
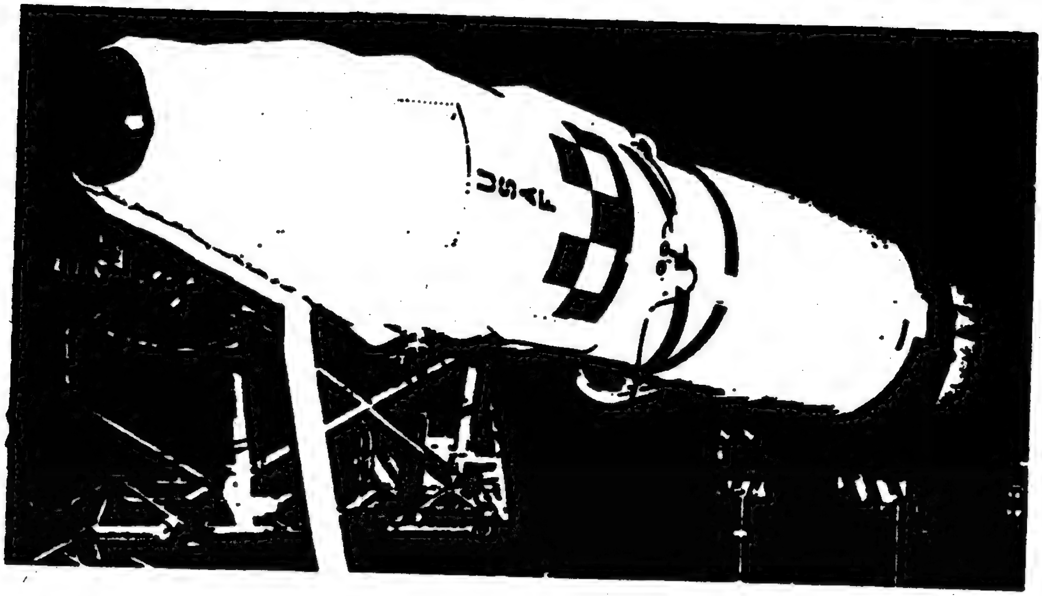


Figure 2. Close-up of AGENA vehicle forward equipment compartment prior to mating with THOR booster.



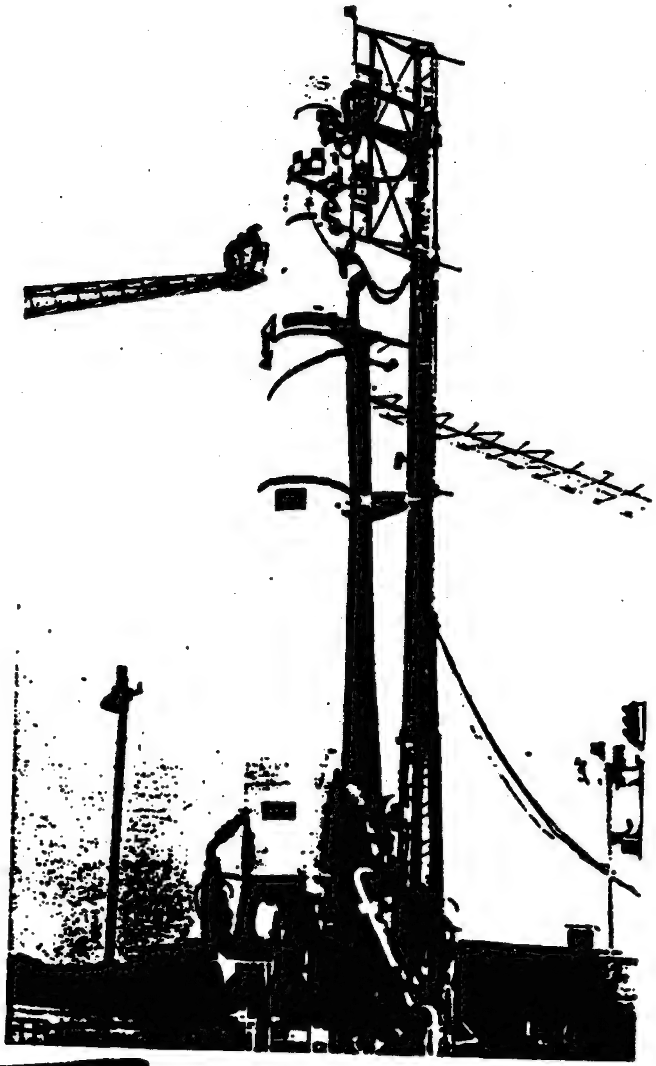


Figure 3. DISCOVERER XIII during pre-dawn countdown on 10 August, prior to erection (above) and during servicing operations following erection on launch pad (right). In top view, the blanket surrounding the nose cone provides air conditioning for capsule electronics during countdown to prevent overheating. The black dome protruding from the blanket is part of the ablative shield which surrounds and protects the capsule during re-entry.

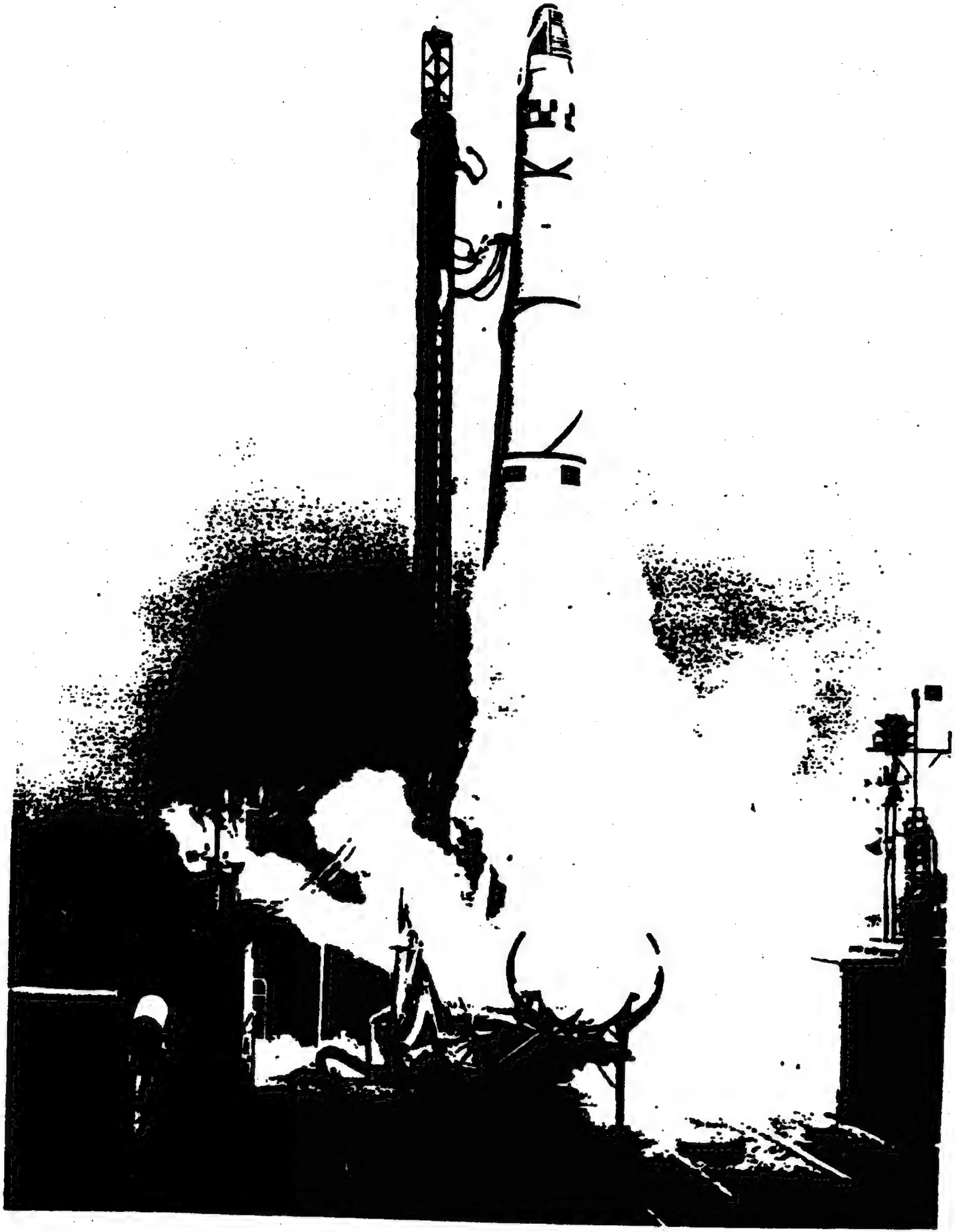


Figure 4. DISCOVERER XIII during lift-off from Vandenberg Air Force Base launch complex on 10 August.

DISCOVERER XIII . . .

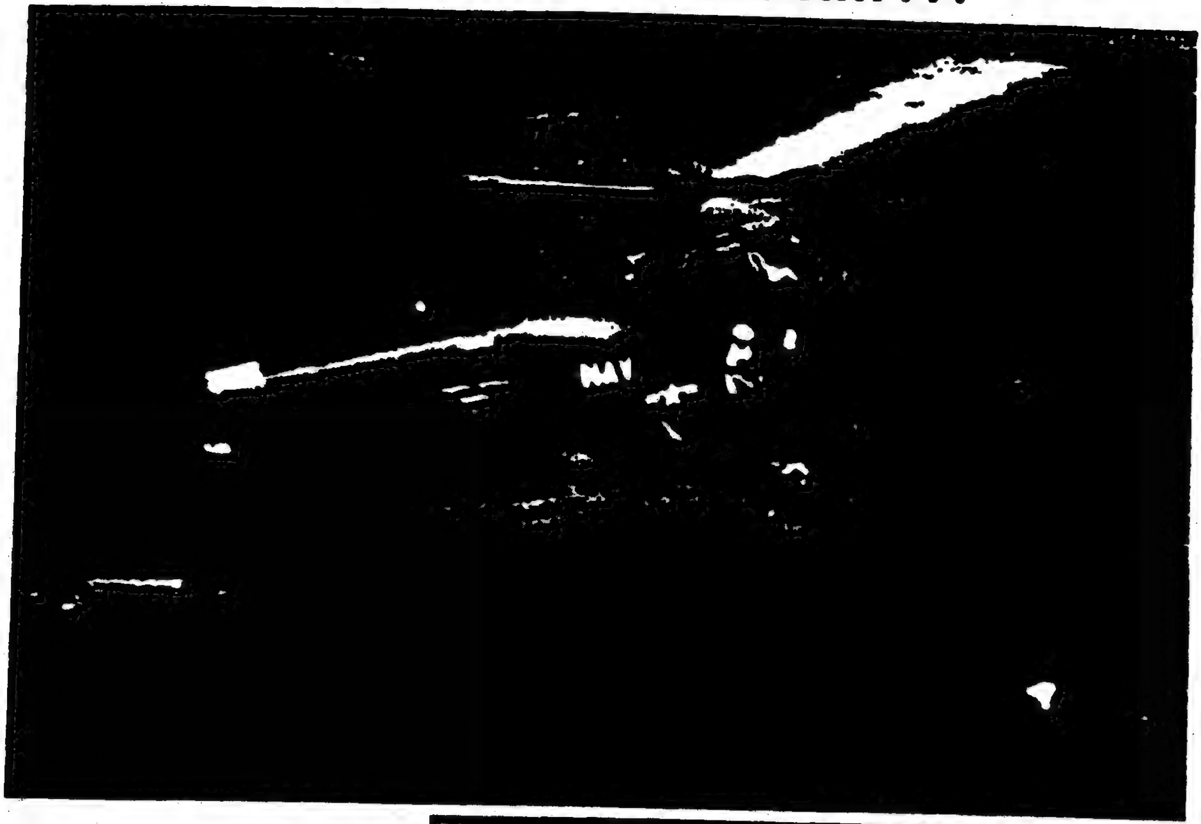
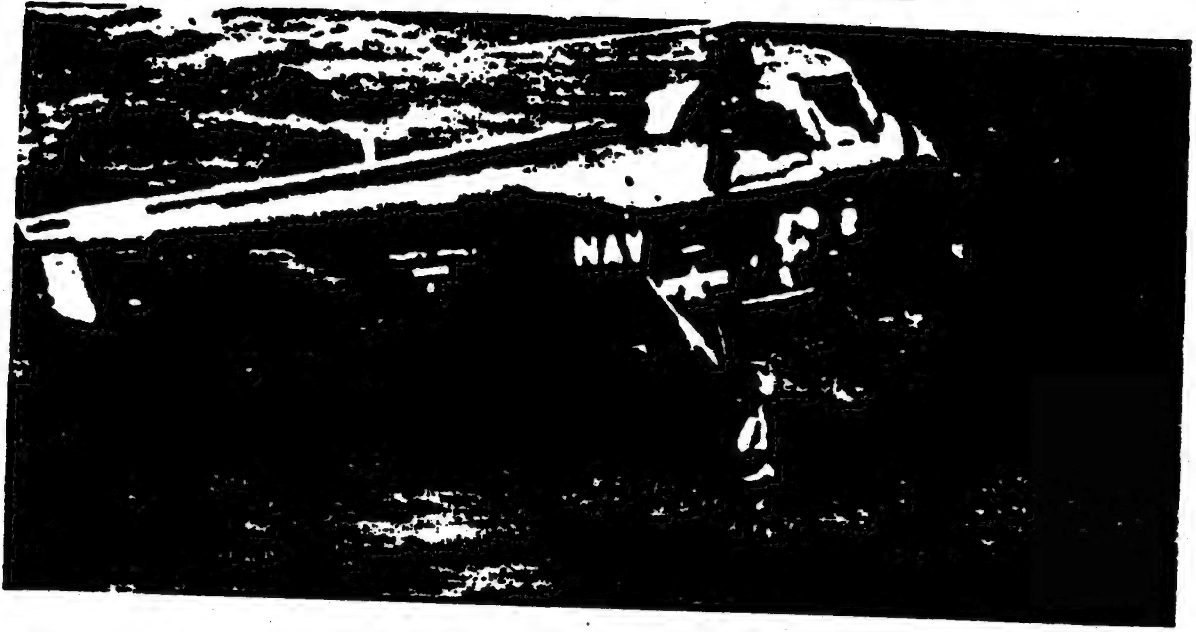


Figure 5. Helicopter recovers DISCOVERER XIII capsule from sea north of Hawaii. Frogman jumps into sea (above) to secure recovery gear to capsule. The capsule is reeled in by the helicopter winch (right) and the frogman is returned to the helicopter (top photo, opposite page). The capsule is shown prior to removal from the helicopter (bottom photo, opposite page), following its return to the recovery force ship "Haiti Victory."

. . . SEA RECOVERY OF CAPSULE



DISCOVERER XIV...

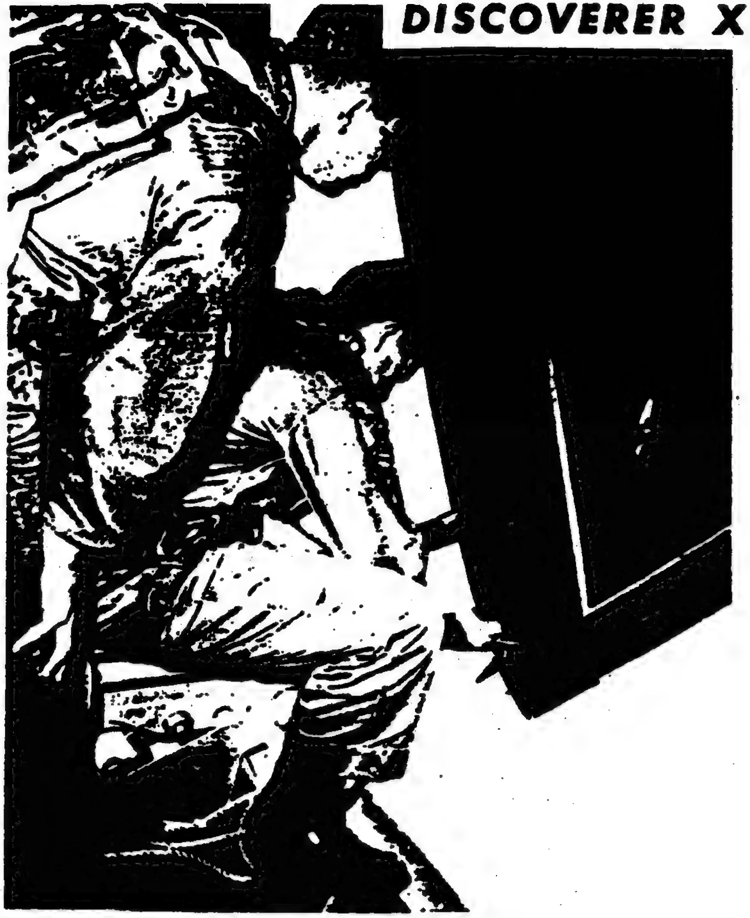
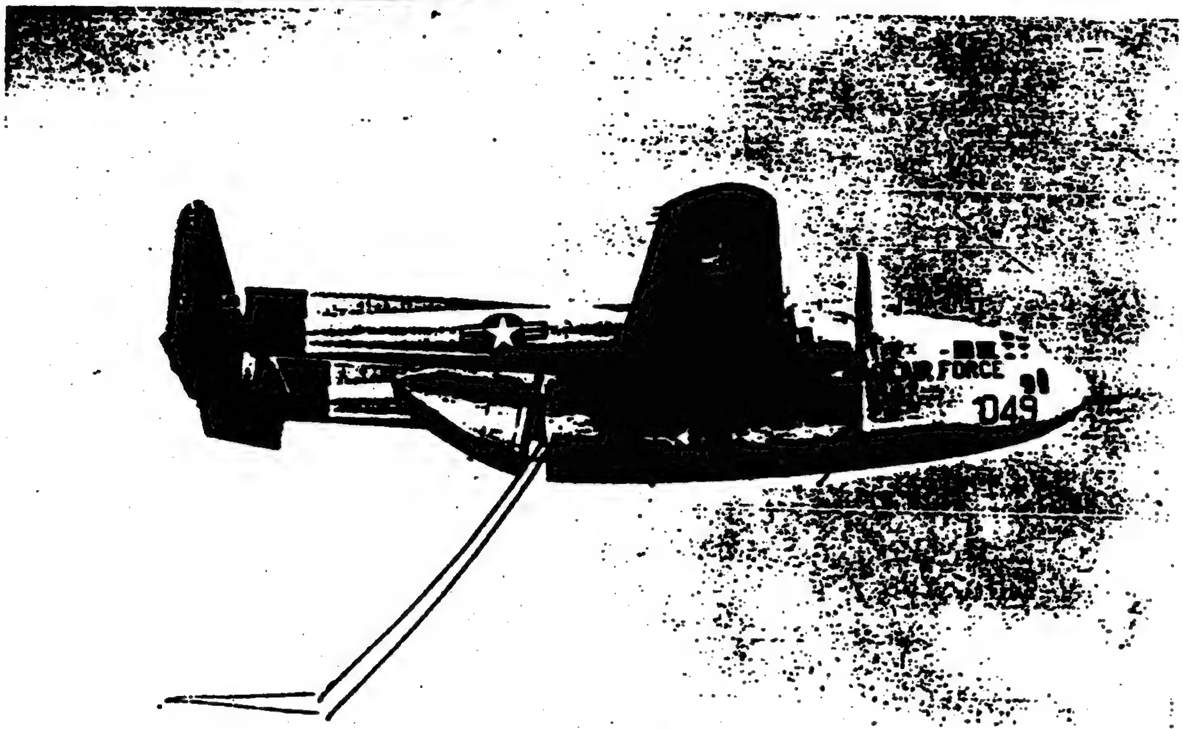
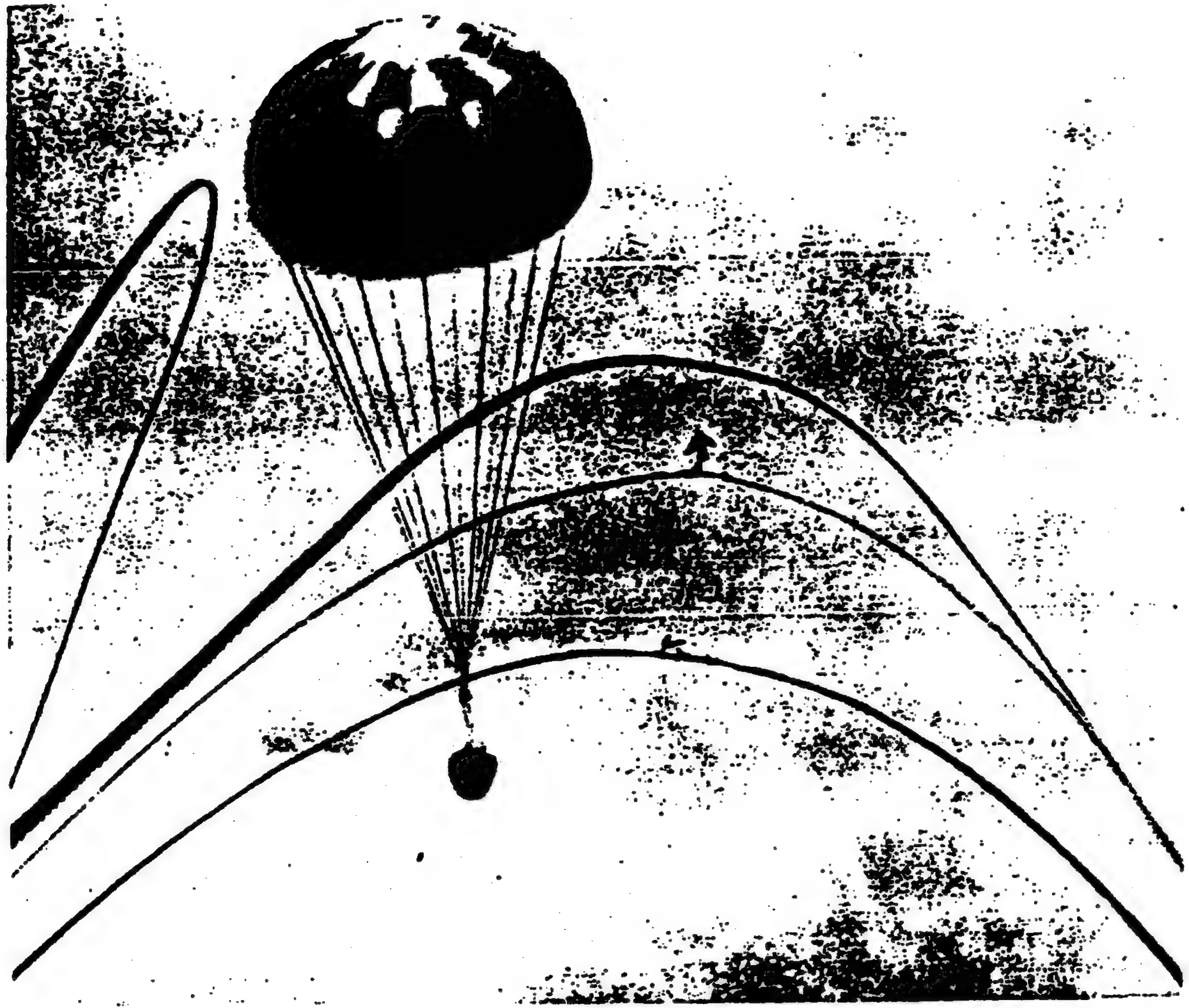


Figure 6. Crewmen aboard recovery aircraft check hook on recovery harness prior to harness deployment.

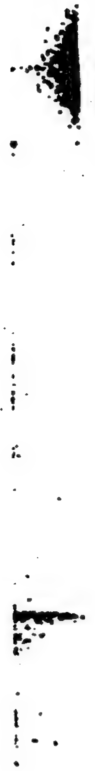
Air Force C-119 patrolling in recovery area north of Hawaii with capsule recovery harness extended.



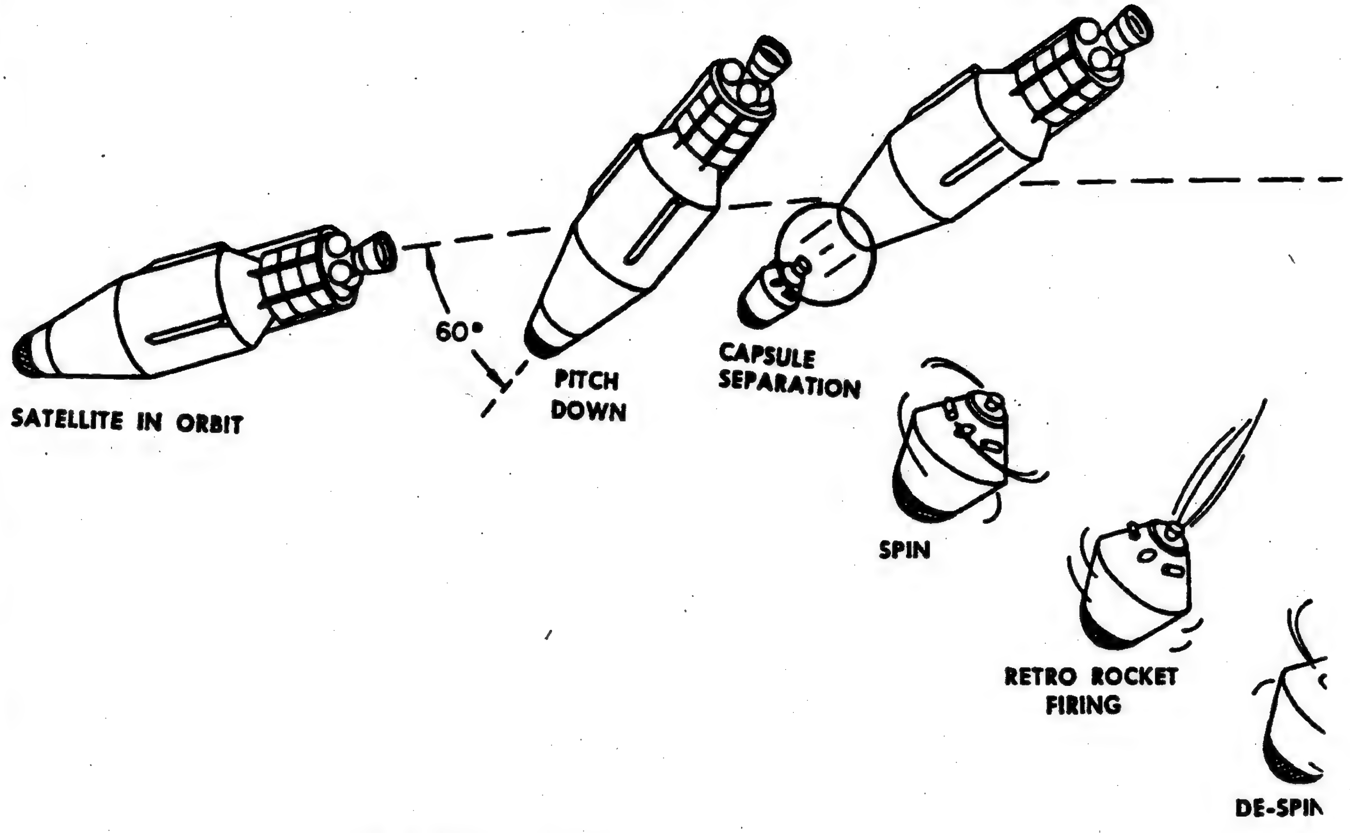
. . . AERIAL RECOVERY OF CAPSULE



Photograph of capsule and parachute taken from within C-119 fuselage on second of two unsuccessful attempts at aerial recovery of DISCOVERER XII.

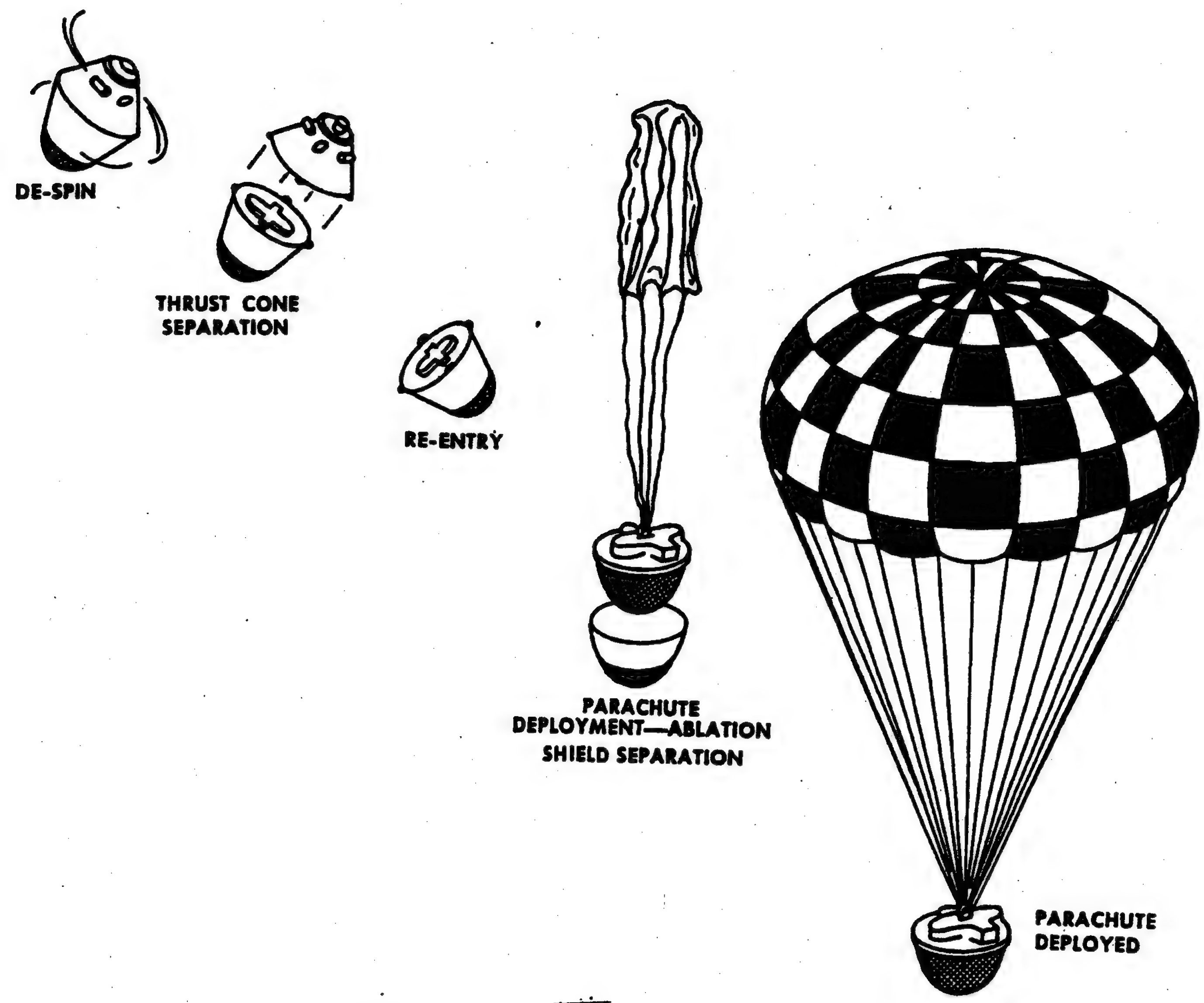


Capsule being r
fuselage by mem-
ery crew.



During its seventeenth orbit (approximately 26 and three-quarter hours after launch) the AGENA vehicle pitches nose down and capsule separation occurs. These operations require about a minute and one half. From launch to capsule ejection the satellite has traveled about 444,000 miles in its elliptical orbit around the earth. The "cold gas" spin system operates, the retro rocket fires and the "cold gas" de-spin system operates. Next the thrust cone separates. The thrust cone contains the spin/de-spin system gas spheres, squib operated valves, manifolds, and exhaust jets; the retro-rocket; the rocket programmer; and the S-band beacon transmitter. The capsule then free falls in much the same position as when it was ejected. Upon re-entry the capsule re-orients itself so that the ablation shield absorbs the intense heat of re-entry. After the two and one-half minute period of re-entry the parachute compartment cover is ejected and the chute unfolds. At this time the ablation shield, having served its purpose, is separated from the capsule. The parachute is deployed at approximately 55,000 feet and the capsule, sending out a signal on which the recovery aircraft "home," descends toward the earth it left only the day before. On recovery, the weight of the capsule is approximately one-third what it was at the time of separation. Items that are no longer needed are ejected to reduce the capsule weight and permit recovery.

DISCOVERER CAPSULE EJECTION, RE-ENTRY, AND PARACHUTE DEPLOYMENT

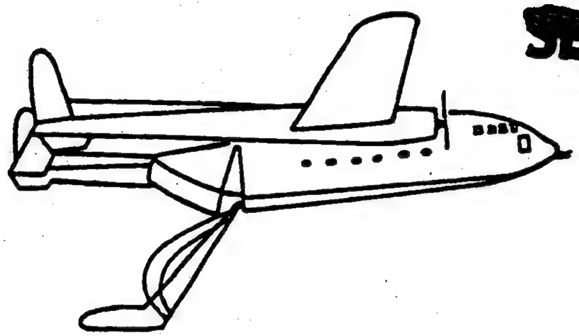


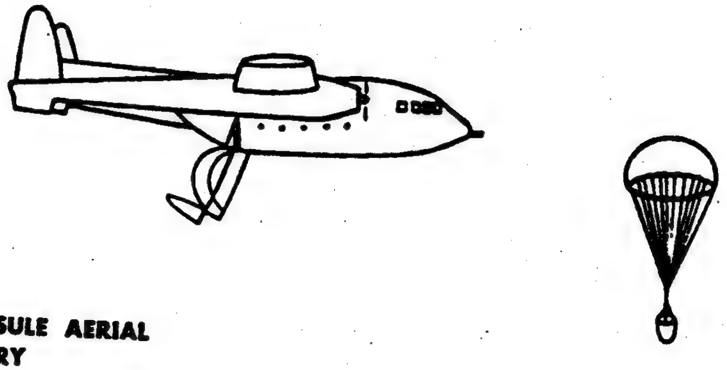
~~[illegible]~~

WDLPM-4-234

Photograph of recovery harness engaging capsule and parachute, taken from within C-119 fuselage on the third recovery attempt.

ed into C-119
s of the recov-



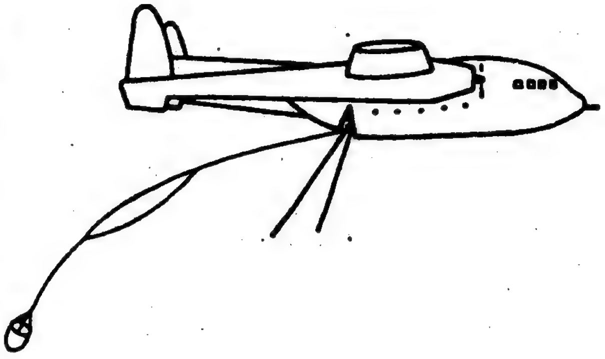


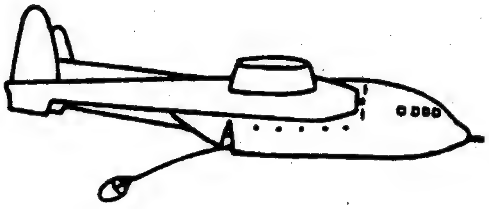
DISCOVERER CAPSULE AERIAL RECOVERY

After capsule ejection from the satellite and re-entry into the earth's atmosphere, the parachute deploys. Parachute deployment occurs at an altitude of approximately 55,000 feet. The crews of C-119 aircraft in the recovery zone "home" in on the signals transmitted by the capsule's beacon and determine their intercept course. They have between 20 and 30 minutes from the time of parachute opening until it impacts into the sea to effect recovery.

The sequence on this page shows contact being made (top center), the aircraft making a pass on the falling capsule (above), the hook of the recovery gear snagging the nylon canopy (above right), and the capsule being hauled into the recovery aircraft. From the time the chute is snagged until it is safely aboard requires from 15 to 20 minutes. If the aircraft cannot effect recovery, surface vessels in the impact area attempt to recover the capsule from the sea. A flashing lite, dye markers, and the transmitter aid them in their search.

Recovery of the DISCOVERER XIV capsule by the Hawaiian based recovery force was the first time in history a man-made object returning from a sustained period in space was recovered by an aircraft.





PARAMETER	NOMINAL	ACTUAL
Apogee, Statute Miles	428	500
Perigee, Statute Miles	118	111
Eccentricity	0.037	0.046
Period, Minimum	93.4	94.5
Inclination Angle, Degree	79.6	19.6
Injection Altitude, Statute Miles	118	118
Injection Angle, Minimum	0	−0.22
Injection Velocity, ft/sec		26,150

TABLE II. DISCOVERER XIV Orbital Parameters

- On the first pass over Kodiak, telemetry data indicated an abnormal satellite attitude, stop indications by the horizon scanner and excessive control gas consumption. The satellite stabilized in its proper attitude on subsequent passes and orbited as planned.

- While on its 17th orbit, the satellite programmer automatically initiated the recovery sequence. The capsule re-entered the atmosphere and its parachute was deployed. A C-119, one of the airborne recovery force, homed on the CW beacon signal and visually sighted the capsule. On the third pass, 1609 PDT, the hooks on the special air-recovery gear snagged the nylon canopy. The chute and capsule were carefully reeled in and at 1623 PST were safely aboard the aircraft. The capsule is presently being analyzed at the contractor's facility.

Technical Progress

Second Stage Vehicles

- Only two DISCOVERER AGENA "A" vehicles remain to be flown. DISCOVERER XV is at Vandenberg Air Force Base in preparation for a September launch. The remaining vehicle is at Sunnyvale for modifications incorporating the improvements from the latest flight tests.

- Two AGENA "B" satellites were delivered to Vandenberg Air Force Base during August and are currently undergoing subsystem checks in the missile assembly building. An additional AGENA "B" has been accepted by the Air Force and is awaiting shipment to Vandenberg Air Force Base. Three vehicles have completed their test firings at Santa Cruz Test Base and are being readied for Air Force acceptance inspections.

- Phase 2 of the Preliminary Flight Rating Tests (PFRT) on the XLR-81Ba-9 engine (serial number 306) were initiated during August. After being retrofitted with flight configuration components the engine was installed on the Bell Test Center vertical test stand for initiation of start-stop and malfunction tests. A 30-second restart firing was accomplished, but test

TABLE III. Space FIRSTS achieved in DISCOVERER Program.

- *The DISCOVERER is the first satellite of major size (above 1,000 pounds) orbited by the United States.*

- *The DISCOVERER is the first satellite to be placed in orbit over the north and south pole.*

- *The DISCOVERER was the first satellite to be reoriented on orbit into a programmed attitude.*

- *The DISCOVERER was the first satellite to be maintained in a stable earth-referenced attitude while on orbit.*

- *The first man-made object ever recovered after a sustained period in space was the capsule ejected from a DISCOVERER satellite.*

Figure 7. Loading one of the telemetry vans into a C-124 aircraft for airlift to the new DISCOVERER ground station at New Boston, New Hampshire.

data indicated a 2.75 percent shift in the power level. The engine was torn down for examination. Tests of this engine are expected to resume early in September.

- The first XLR-81Ba-9 engine (serial number 316) delivered with flight configuration hardware, has successfully completed acceptance testing. One engine (serial number 317) has been hot fired but operation was unstable and the power level dropped. Analysis disclosed that the gas generator venturies required resizing and that the oxidizer filter was improperly installed. This engine is now being prepared for final acceptance testing.

Balloon Drop Test Program

- The drop test program continued at Holloman Air Force Base with two test attempts on 4 August.

The first balloon burst at 30,000 feet, before the planned drop of the Mark IV capsule, however, the equipment was recovered successfully. On the second the capsule was dropped and parachute deployment was satisfactory. The purpose of these tests was to determine if the new parachute cover would release properly during capsule deceleration. The Mark IV capsule is similar to the recently recovered capsules but contains an improved programmer and other modified components.

Facilities

- Acceptance of the air conditioning system modification for the Vandenberg Air Force Base data acquisition and processing building was made following successful completion of an equipment test run.

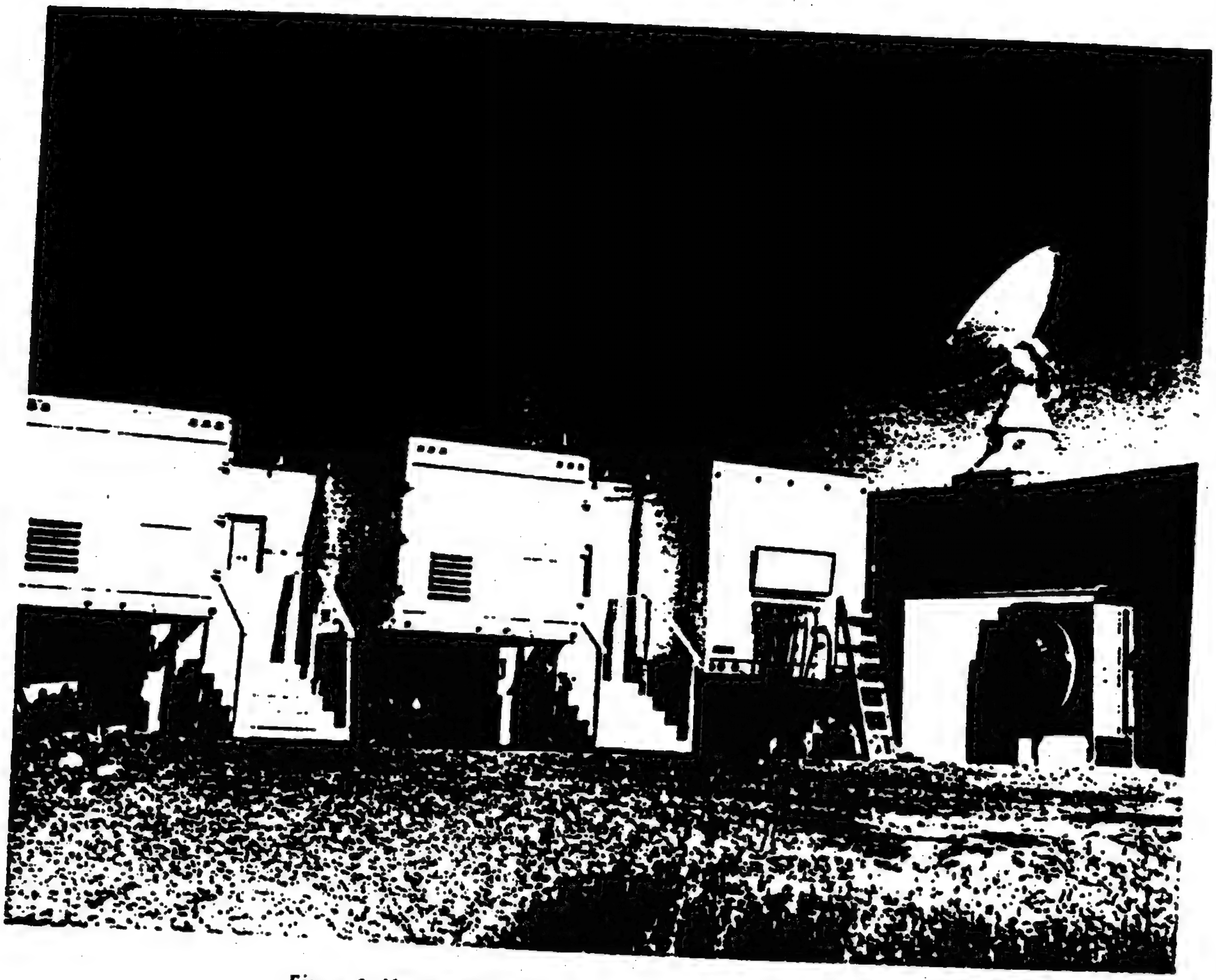
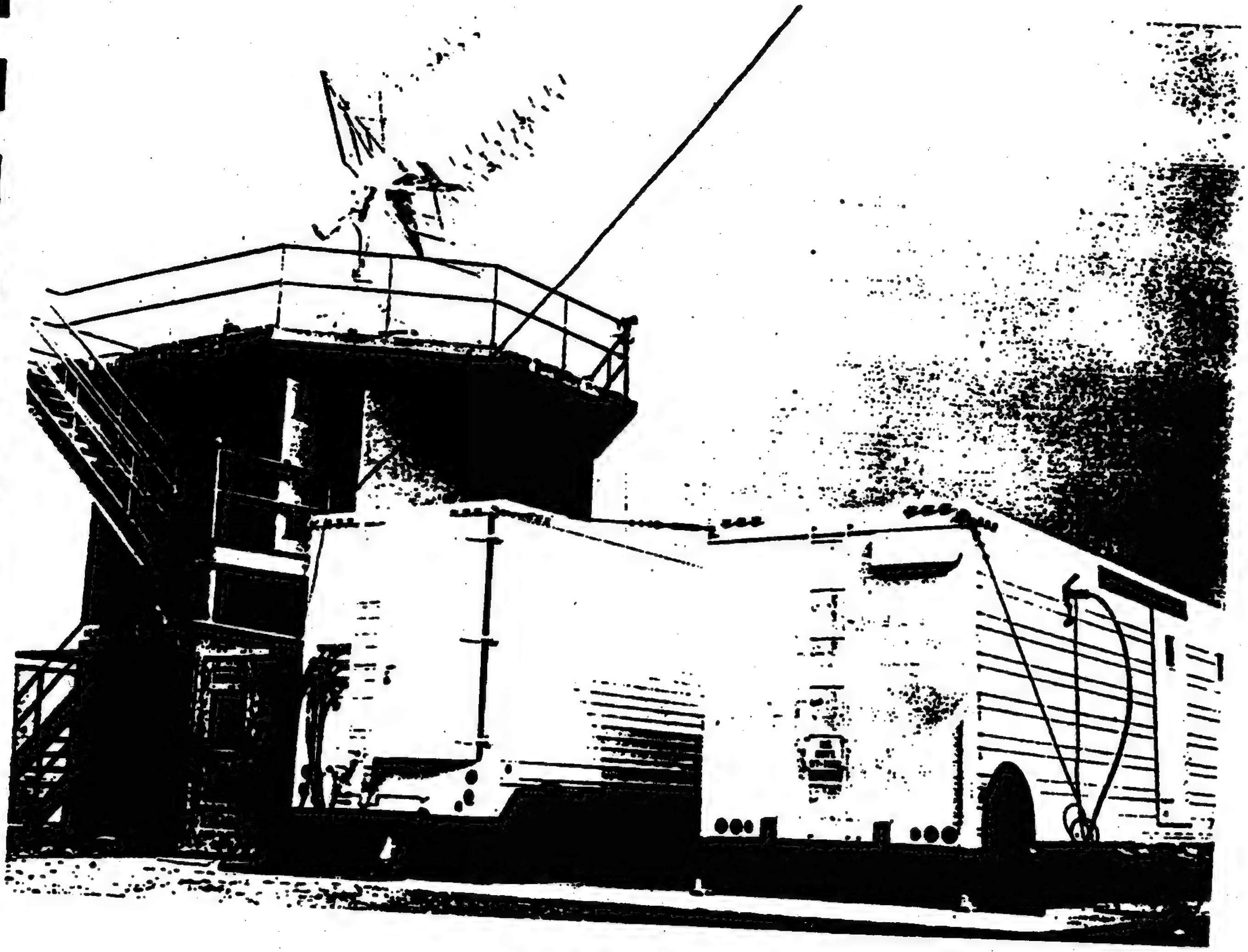


Figure 8. Vans installed alongside facilities buildings at new DISCOVERER ground station at New Boston, New Hampshire.

- Installation of a DISCOVERER ground station at the New Boston, New Hampshire, facility was completed and checked out on 17 August. Installation of equipment was started in July. The station has the capability for Verlort radar tracking, command and telemetry reception. Construction of support facilities is on schedule. The initial increment of support facilities was accepted on 2 August with the remainder scheduled for completion on 7 September.



Samos

BOOSTER—ATLAS ICBM

Weight—Wet	15,100
Fuel, RP-1	74,900
Oxidizer (LOX)	172,300
GROSS WEIGHT (lbs.)	262,300
Engine—MA-2	
Thrust (lbs. vac.) Boost	356,000
Sustainer	82,100
Spec. Imp. (sec. vac.) Boost	286
Sustainer	310

SECOND STAGE	AGENA "A"	AGENA "B"
Weight—		
Inert	1,508	1,695
Payload equipment	2,605	3,058
Orbital	4,113	4,753
Impulse Propellants	6,492	12,950
Fuel (UDMH)		
Oxidizer (IRFNA)		
Other	606	718
GROSS WEIGHT (lbs.)	11,211	18,421
Engine	YLR81-Ba-5	XLR81-Ba-9
Thrust, lbs. (vac.)	15,600	16,000
Spec. Imp., sec. (vac.)	277	290
Burn Time, sec.	120	240

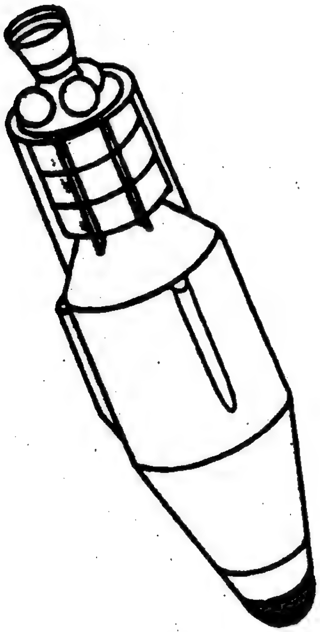
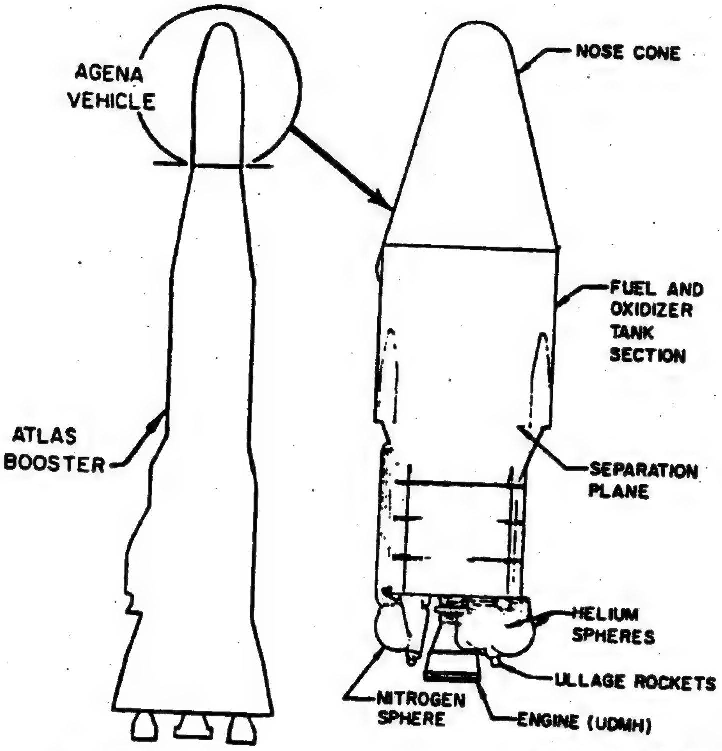


Figure 1.

Artists' concept of SAMOS satellite. Line drawing of complete flight vehicle (right) and detailed view of basic AGENA upper stage (left).



PROGRAM HISTORY

The SAMOS Program was included in Weapon System 117L when WS 117L was transferred to the Advanced Research Projects Agency early in 1958. ARPA separated WS 117L into the DISCOVERER, SAMOS and MIDAS programs with the SAMOS objectives based on a visual and ferret reconnaissance system. On 17 November 1959 responsibility for this program was transferred from ARPA to the Air Force by the Secretary of Defense. The program was realigned on 11 August 1960 to emphasize visual reconnaissance over ferret and physical recovery of data over electronic readout.

PROGRAM MISSION

The primary mission of the SAMOS advanced reconnaissance system is to provide visual and electronic coverage of the USSR and its allied nations. Efforts include development of hardware to permit:

a. Verification of known targets, detection of unknown targets.

b. Location and evaluation of defenses.

c. Evaluation of military and industrial strength.

d. Assessment of high-yield weapons damage.

e. Reconnoitering of troop movements.

f. Location of naval forces throughout the world.

g. Determination of characteristics of enemy electronic emissions.

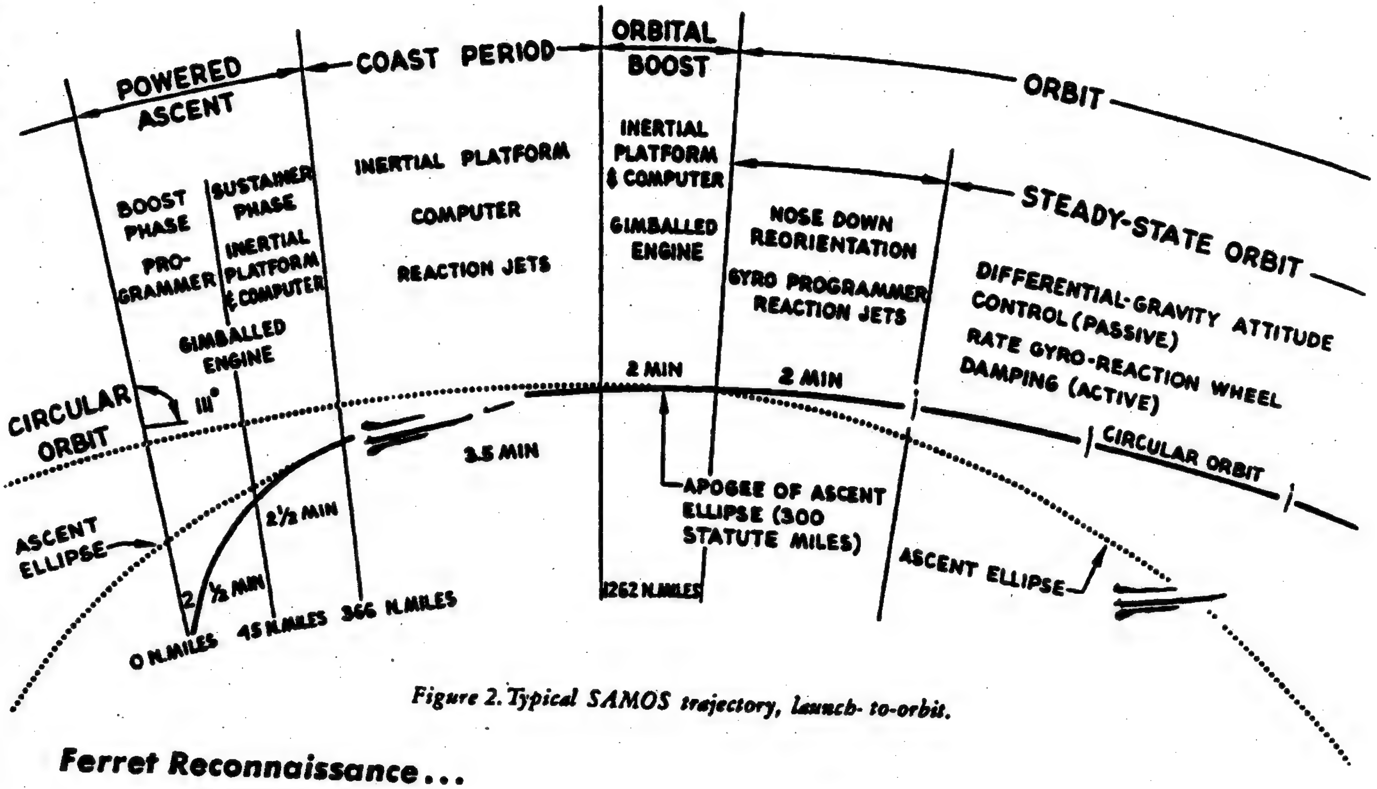


Figure 2. Typical SAMOS trajectory, launch- to-orbit.

Ferret Reconnaissance . . .

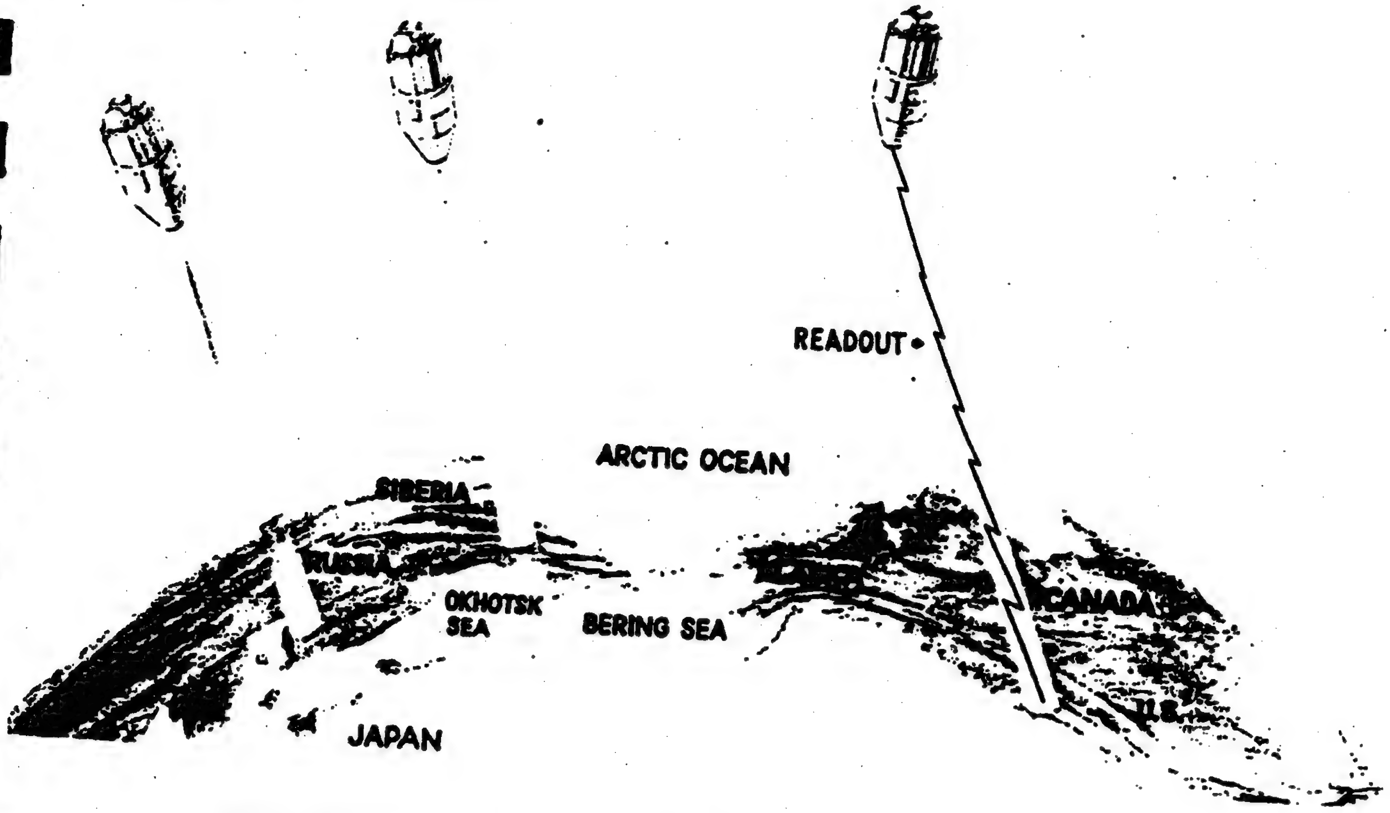


Figure 4. The Ferret reconnaissance system will gather data from electronic emissions over areas of interest.

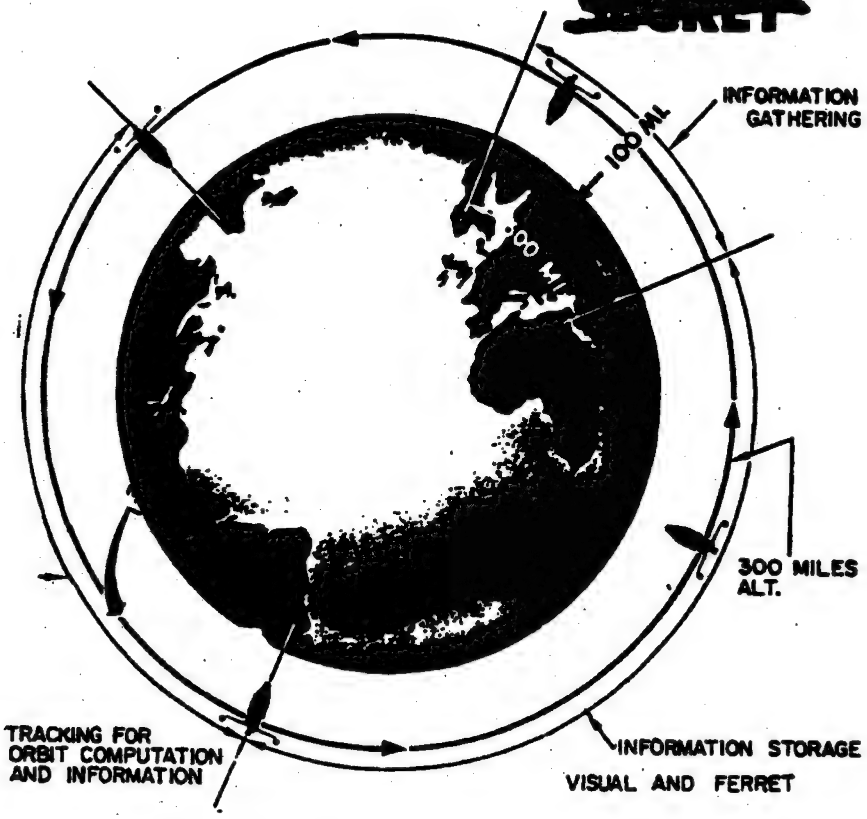


Figure 3.
Schematic of SAMOS system in operational orbit. When the satellite is over the area of interest the sensing equipment is turned on (Information gathering). When it leaves the area of interest the sensing equipment is turned off and the sensing data is processed (Information storage). When the vehicle comes within range of a ground receiving station, the data will be read-out upon command for processing and transmitted to using agencies. This process is continuously repeated during the useful lifetime of the vehicle.

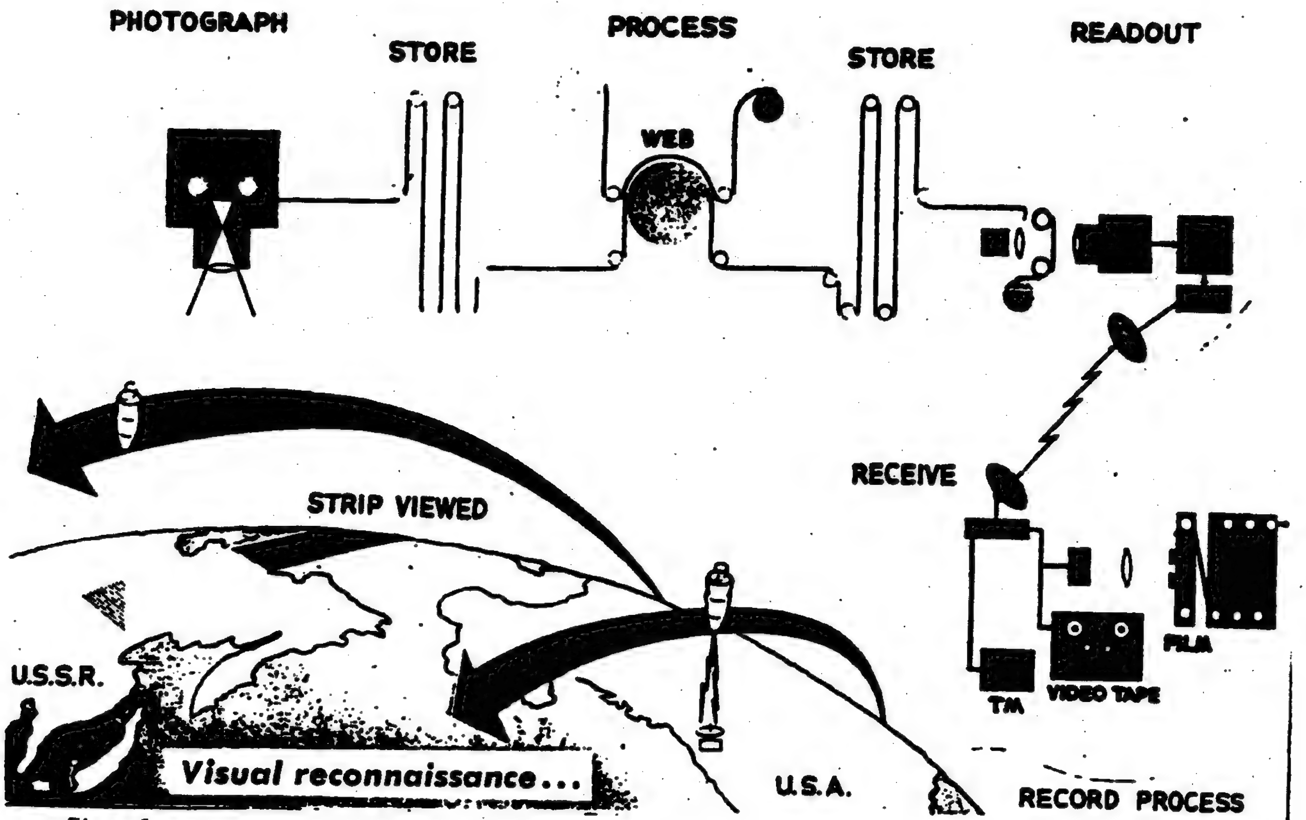


Figure 5.
The initial visual reconnaissance program will use conventional photo techniques with automatic film processing and TV-type electronic image readout to ground stations thru a data link. Ground electronics will reconvert the signal into photo image form, with a capability of resolving objects 20 feet in length.

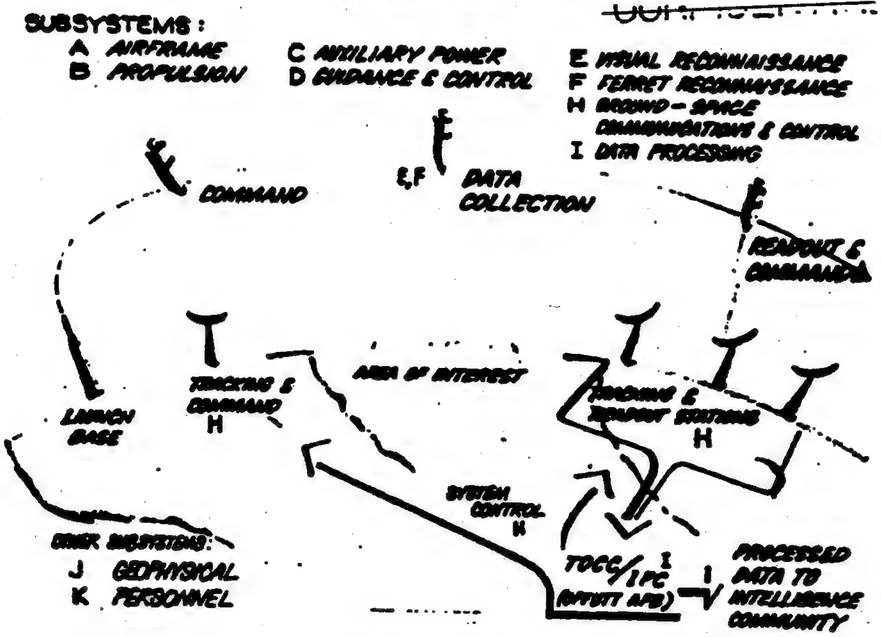


Figure 6. SAMOS concept, showing reception of commands and transmission of data between satellite and ground station; and subsystem functions (schematic).

For economical testing of components a dual-capability visual and ferret payload will be flown on the first 3 flights. On later flights only a visual or ferret system payload will be carried. These payloads will be housed in the AGENA vehicle (Figure 1). Data collected by the visual payloads will be electronically transmitted in the readout system or physically recovered in the recovery system. Ferret data will be transmitted electronically. These systems are composed of the AGENA vehicle, ATLAS booster, launch facilities, tracking facilities, and a communications and data processing network. The recovery system will include a re-entry capsule and a recovery force.

CONCEPT

ATLAS Series D missiles launched from VAFB will boost the AGENA vehicle into polar orbits. Injection into near-circular orbits (Figure 2) will be accomplished by the AGENA vehicle rocket engine. A self-contained guidance system using a horizon reference scanner will provide altitude stabilization. As the satellite travels in an orbit essentially fixed in space the earth rotates inside the orbit (Figure 3). Each successive orbit is displaced laterally approximately 23½ degrees at the equator, permitting one vehicle to observe the entire earth in a time period dependent upon the width of the area under surveillance. Early versions will have a useful life of approximately ten days. The readout systems will have a useful life of four months with a design objective in certain configurations of one year; recovery systems will have a useful life of fifteen to thirty days.

TECHNICAL DESCRIPTION

Visual Program—Four versions (E-1, E-2, E-5 and E-6) of visual payloads are being developed. The E-1 payload is a photo component test payload which is combined with the F-1 ferret payload. The E-2 photographic payload, under development by Eastman Kodak Company, includes a camera, film processor, and electronic readout equipment. The E-5 recoverable system designed by Lockheed will retain the exposed film and the 66-inch focal length camera developed by Itek Corporation. The E-6 payload is a medium resolution, general area coverage, photographic recoverable subsystem being developed as an alternate to the E-5. The E-6 is now in the source selection phase.

Ferret Program—Ferret payloads are being developed on a progressively more advanced basis from R&D (F-1) to advanced systems (F-4). Although only the F-1 and F-2 are included in the flight test schedule. The F-2 all-digital, general coverage payload will use superheterodyne scanning receivers in conjunction with directional antennas, an analog to digital converter and tape recorders (for storage). A programmer will be used to control read-in over areas of interest and readout over tracking stations. The F-3 payload will use similar receivers with stop-scan capability and controllable antennas added. Recording of the actual signal intercepted (rather than the digital representation) will be possible with a bandwidth up to 6mc. A complex programmer will permit satellite search of a given area or frequency range.

	60												61												62											
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
										1	1		1			1		1	1	1	1	1	1	1	1	1		2	1	1		2	1	2	3	1
VEHICLE CONFIGURATIONS	ATLAS "D"/AGENA "A"													ATLAS "D"/AGENA "B"																						

SAMOS Launch Schedule

Monthly Progress—SAMOS Program

Technical Progress

Second Stage Vehicles

- The second stage vehicle for the first SAMOS flight has undergone systems tests throughout the report period at Vandenberg Air Force Base. The tests were successfully concluded on 17 August following a simulated launch. Late equipment deliveries and the requirements for full-scale RF interference check (because of the DISCOVERER XII horizon scanner problem) resulted in rescheduling the on-stand date from 19 August to 2 September. This revised on-stand date is compatible with the requirement of not installing the AGENA until after completion of the ATLAS booster flight readiness firing (FRF). The ATLAS FRF was successfully completed on 23 August. Launch of the first SAMOS flight is now scheduled for 4 October. This date will permit the telemetry ship Pvt. Joe E. Mann to return on station, following its support of the DISCOVERER recovery operation.

- The two remaining SAMOS AGENA "A" dual payload satellites are proceeding through modification and checkout in the system test area. These vehicles are approximately six-to-eight weeks behind schedule. This delinquency was caused by late delivery of flight and space airborne communications

Figure 7. The AGENA "A" vehicle for the first SAMOS flight undergoing auxiliary power subsystem checkout at Vandenberg Air Force Base. The test fixture on the extreme left is used in checking the satellite's inertial reference unit. The inertial reference unit and the horizon scanner provide the attitude reference for the AGENA flight control system.

equipment, the one month duration strike, and the decision to incorporate engineering changes in the systems test area which were formerly programmed for Vandenberg Air Force Base. This change was made in the interest of decreasing the time required for the missile assembly building phase of prelaunch operations. Although there are no airborne communications equipment delinquencies at this time, previous delays have made schedule recovery almost an impossibility.

- The stacking of major components for the first AGENA "B" (single payload) vehicle was completed on 23 August. The vehicle has now entered the final assembly phase of manufacture. The XLR81-Ba-9 engine (45:1 area nozzle ratio) was received in mid-August. Delivery has also been made of the guidance control system inertial reference package and its associated electronic items.

Visual Reconnaissance Systems

Visual Reconnaissance Systems payloads are being developed in a minimum number of configurations to attain readout and recovery mission objectives. The design and purpose of each configuration is as follows:

Readout:

- **E-1—Component Test Payloads**
- **E-2—Steerable Reconnaissance Payload (with 20-foot ground resolution)**

Recovery:

- **E-5—High Resolution, Steerable, Recoverable Payload (with 5-foot ground resolution)**
- **E-6—Medium Resolution, General Area Coverage, Recoverable Payload (with at least 10-foot ground resolution)**

Payloads

E-1 Payload—Checkout and testing of the E-1 payload continues to proceed on schedule at Vandenberg Air Force Base.

E-2 Payload—Final assembly of the E-2 payload for the fourth SAMOS flight was completed during the report period. Subsequent functional testing of the completed payload has resulted in modifications to the processor web feed system. Eastman Kodak is expending maximum effort to incorporate these improvements with a minimum delivery schedule slip-

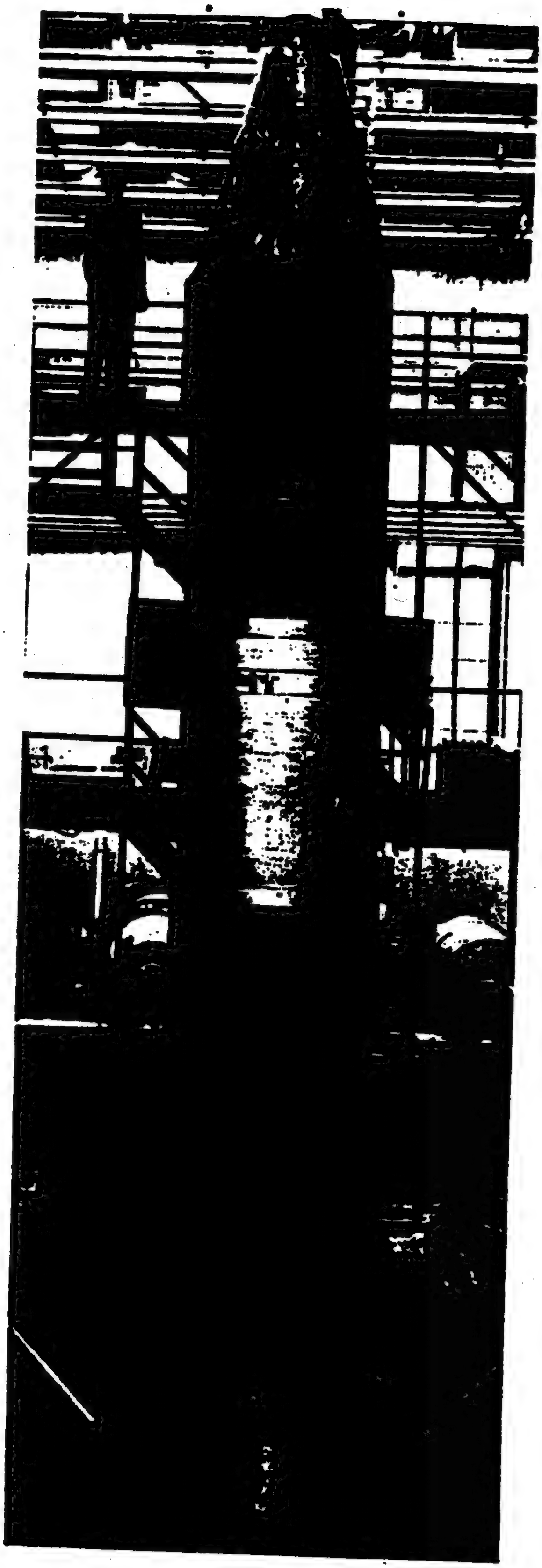


Figure 8. Stacking or premating of the major components of the AGENA "B" vehicle for the fourth SAMOS flight. This vehicle has twice as much propellant capacity as previous vehicles and will be flown carrying an E-2 payload. Following this operation, the AGENA structural assemblies are mounted horizontally in a stand for installation of the engine and other flight components.

page. Delivery of the payload is not expected until mid-September.

E-5 Payload—Design releases for the full-scale test models of the E-5 recovery capsule have been completed and fabrication of the initial test articles is progressing satisfactorily. A thermal model of the E-5 payload, for testing in the high altitude temperature simulator, was completed during the month. Delivery of this thermal model is programmed for early September.

- Wind tunnel tests for the purpose of confirming the E-5 recovery capsule basic aerodynamic configuration are essentially complete. The force oscillation tests at Langley Field, to determine dynamic stability characteristics in the 2.3-5 Mach range, were completed on 10 August. Tests in the transonic range are scheduled to begin in early September.

- Preparations are continuing for the shock tunnel tests at high angles of attack and low Reynolds numbers to be conducted at the Cornell Aeronautical Laboratories. These tests are programmed to begin on 3 October. The aerodynamic/thermodynamic tests of the ablative heat shield, originally scheduled to begin at the Avco Corporation in early August, have been delayed because of technical difficulties with the test facilities.

- Two Recovery Equipment Test Units (RETU) tests have been conducted at Edwards Air Force Base. The purpose of these tests was to determine the E-5 capsule drag and oscillation characteristics during retrieval into the recovery aricraft. Because the RETU was lost during the deployment phase, neither test was completed. Some data were obtained and are currently being evaluated.

- Test results of the stability and rate of descent characteristics of a single main parachute versus a clustered main chute configuration are still being evaluated. Based on visual observation of tests com-

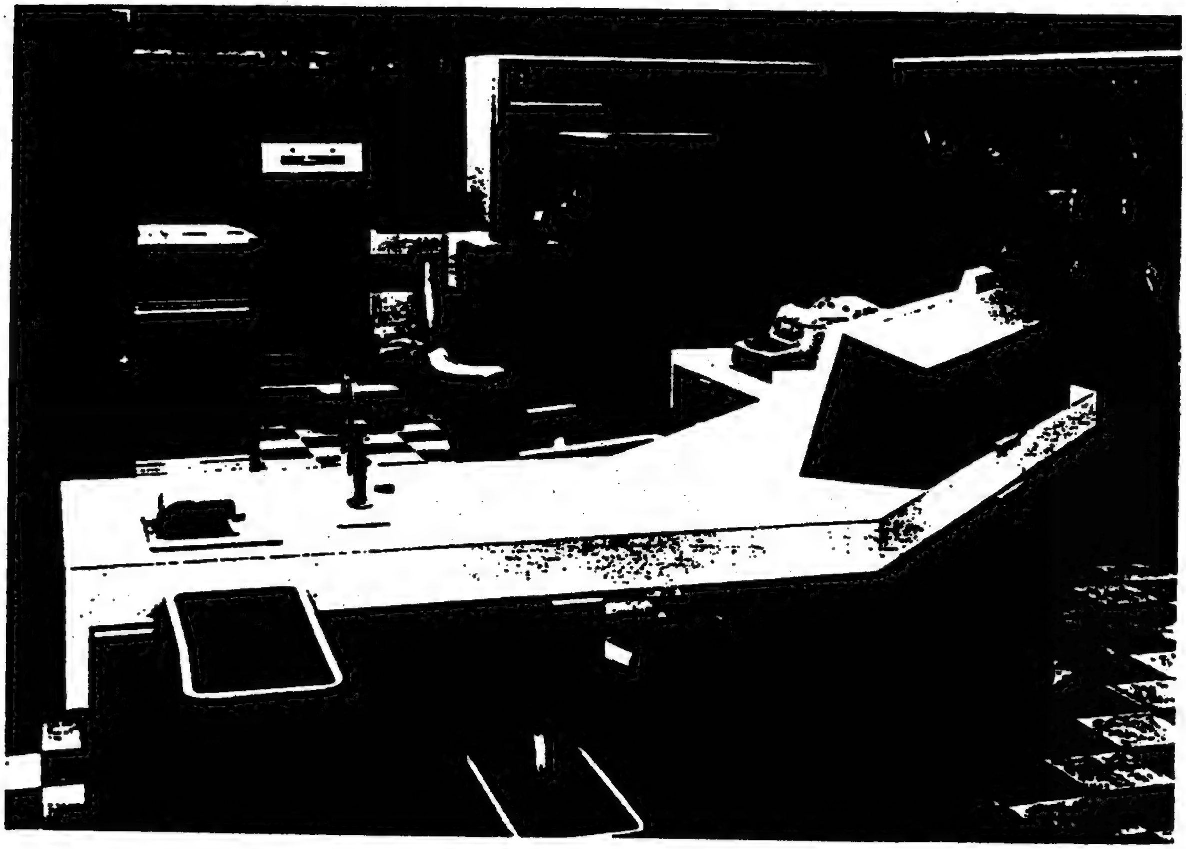


Figure 9. Model 1604 computer installation in the Vandenberg Air Force Base data acquisition and processing building. This high speed computer is especially well adapted to the real time operations required in satellite programs. A similar computer installation is located at the Satellite Test Center.

pleted to date at El Centro, California, the single chute system appears more desirable from the stability standpoint. Structural integrity tests of the E-5 stabilization chute were initiated late in August.

Ferret Reconnaissance System

Ferret Reconnaissance System payloads are being developed in a minimum of configurations. The desigation and purpose of each configuration is as follows:

F-1—Component Test Payloads
F-2—Digital General Coverage Payloads
F-3—Specific Mission Payloads—
Analog signal recording
F-3—Specific Mission Payloads—Analog signal recording

Payload

F-1 Payload—Checkout and testing of the F-1 payload is proceeding on schedule at Vandenberg Air Force Base.

Ground Support Equipment

- The installation and checkout of Point Arguello Pad No. 1 ground support equipment has been completed, with minor exceptions. These will have no effect on the launch schedule. The ATLAS flight readiness firing on 23 August demonstrated the readiness of the ATLAS ground support equipment.

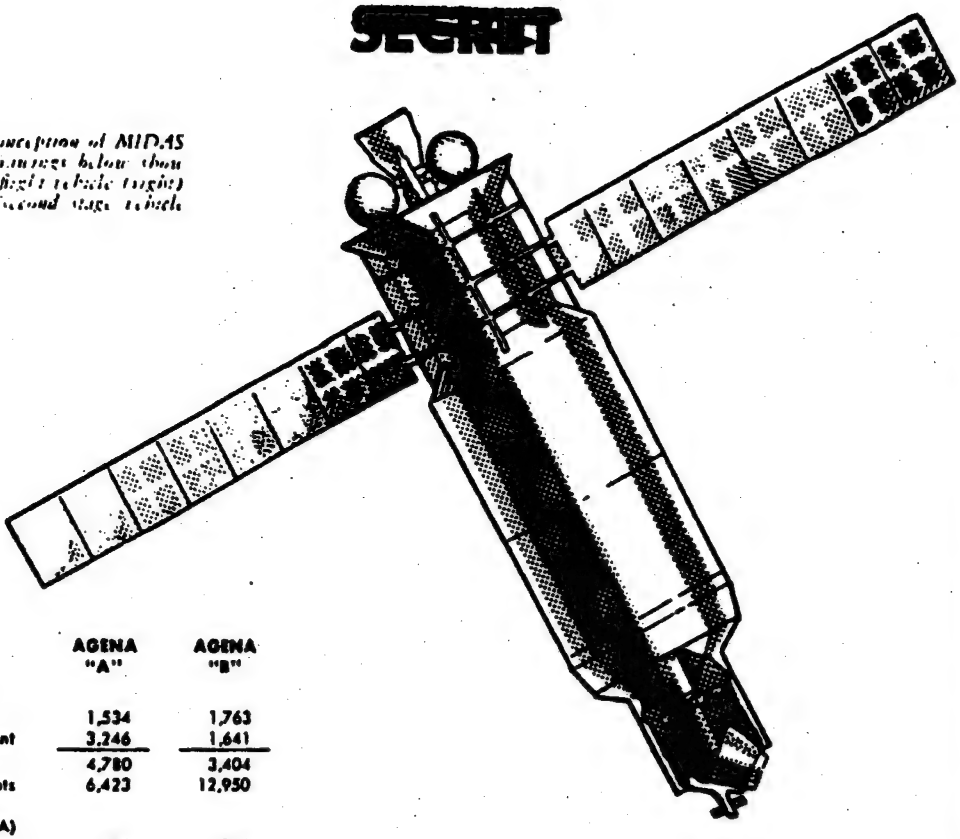
Facilities

- The architectural and engineering phase of the modifications to accommodate an R&D data processing facility in the satellite test center is complete. Construction of the required changes is scheduled to begin in early September. Approximately 70 percent of the equipment to be installed in the data processing facility is on hand. The over-all effort to have this facility ready by mid-September is progressing satisfactorily.

- The contract for construction of the Point Arguello diesel generator building was awarded on 29 August.

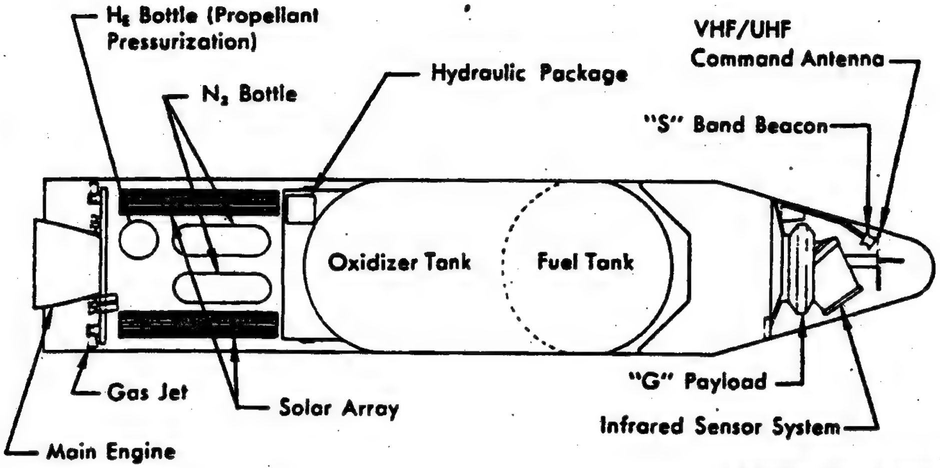
- Design of the Vandenberg Air Force Base helium unloading and storage facility has been initiated with final design review scheduled for 9 September.

Figure 1. Artist's conception of MIDAS satellite (right). Drawings below show complete two-stage flight vehicle (right) and AGENA "B" second stage vehicle (left).



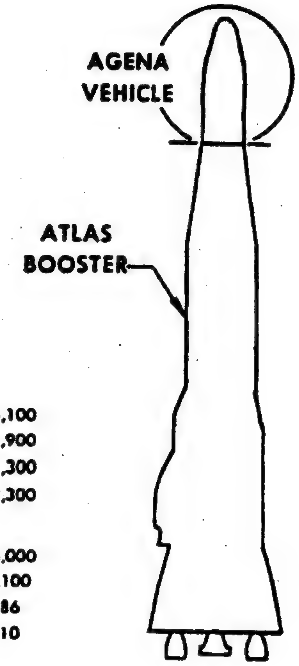
M
i
d
a
s

SECOND STAGE	AGENA "A"	AGENA "B"
Weight—		
Inert	1,534	1,763
Payload equipment	3,246	1,641
Orbital	4,780	3,404
Impulse Propellants	6,423	12,950
Fuel (UDMH)		
Oxidizer (IRFNA)		
Other	606	758
GROSS WEIGHT (lbs.)	11,809	17,112
Engine	YLR81-Ba-5	XLR81-Ba-9
Thrust, lbs. (vac.)	15,600	16,000
Spec. Imp., sec. (vac.)	277	290
Burn Time, sec.	120	240
Restart Provisions	No	Yes



MIDAS, Configuration II, AGENA "B" Satellite

BOOSTER—ATLAS ICBM	
Weight—Wet	15,100
Fuel, RP-1	74,900
Oxidizer (LOX)	172,300
GROSS WEIGHT (lbs.)	262,300
Engine—MA-2	
Thrust (lbs. vac.) Boost	356,000
Sustainer	82,100
Spec. Imp. (sec. vac.) Boost	286
Sustainer	310



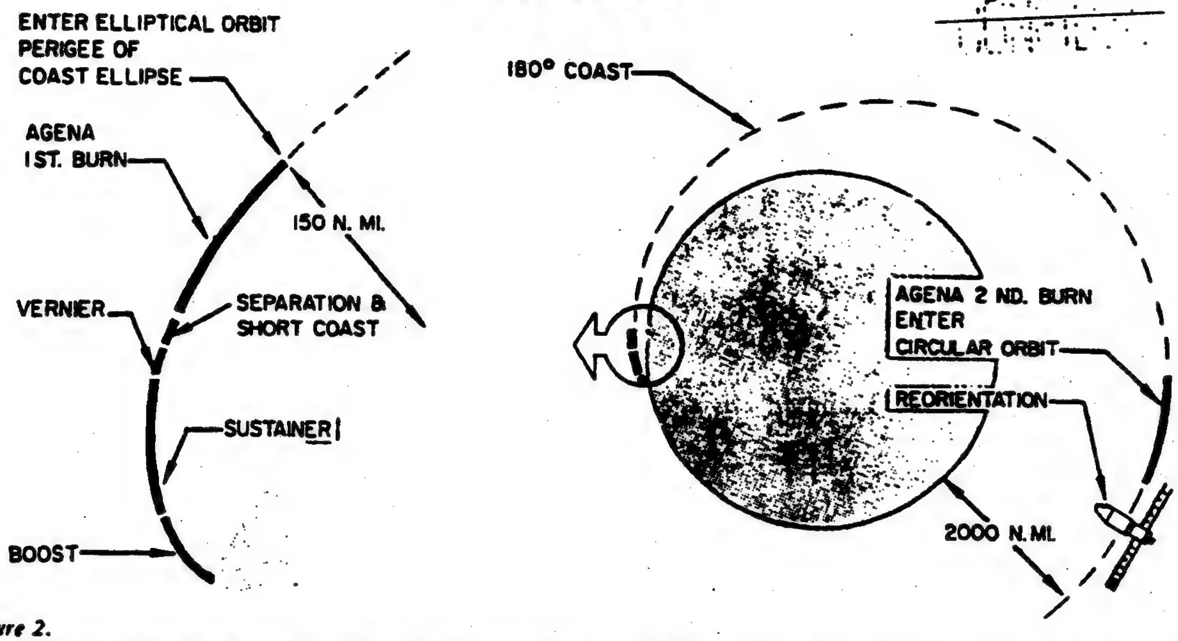


Figure 2.
Launch-to-orbit trajectory for flights 3 and subsequent. From boost through separation guidance and control is provided by the ATLAS radio inertial system. The AGENA inertial guidance system, with horizon scanner, provides attitude, velocity and directional control to establish the orbit and vehicle orientation.

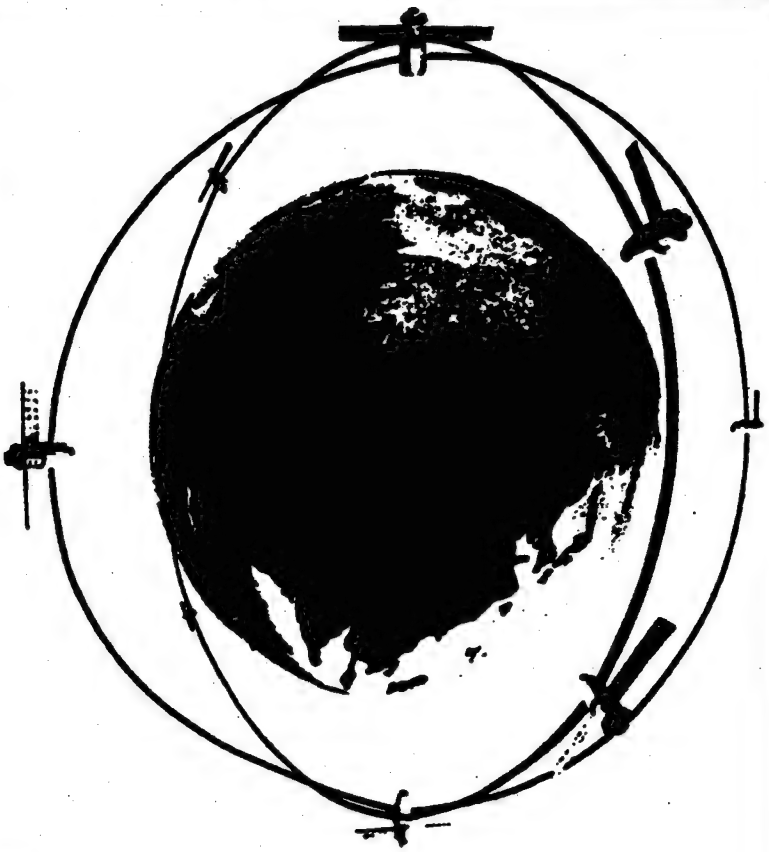


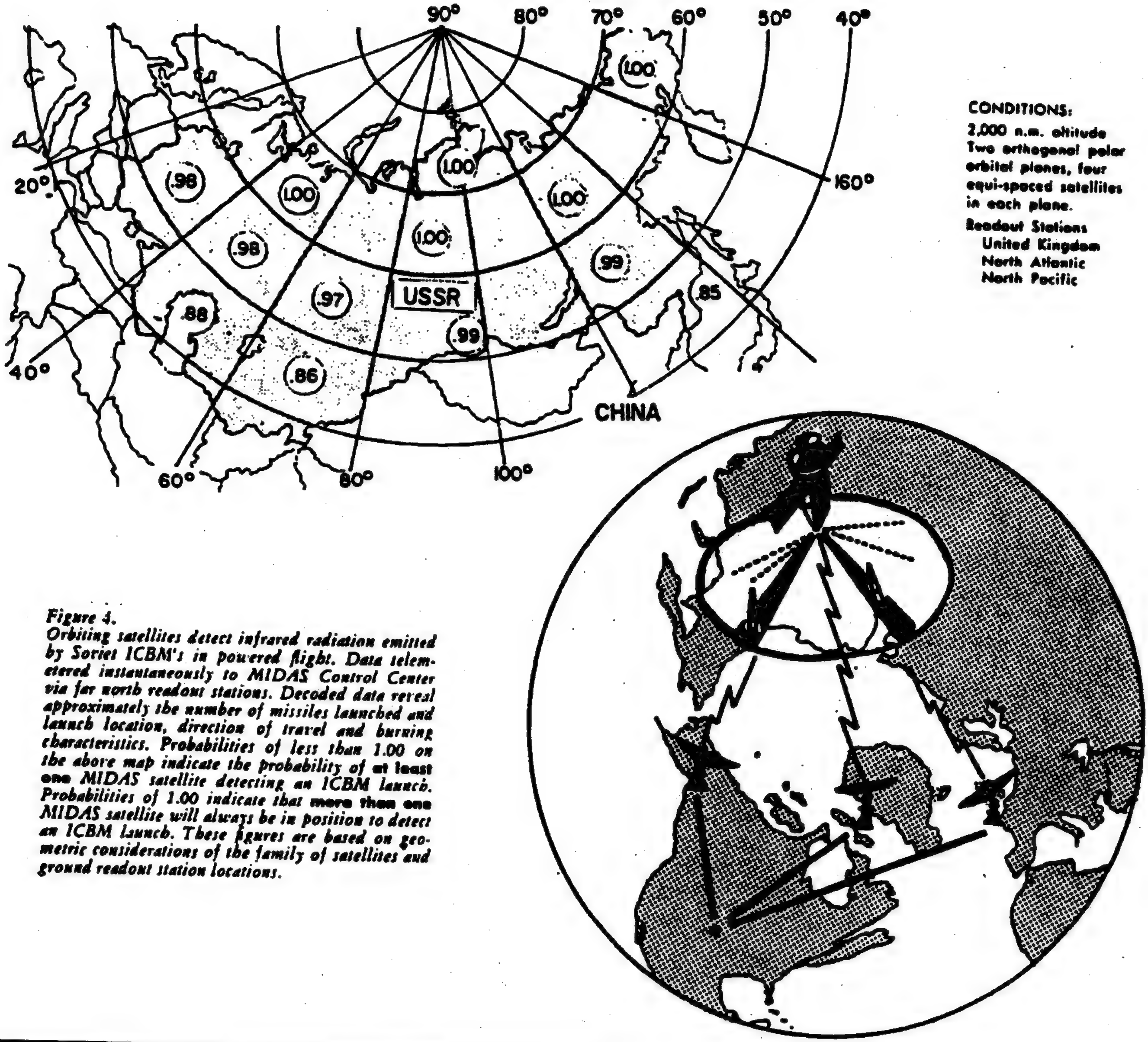
Figure 3.
Proposed MIDAS system. Four satellites spaced equidistant in each of two orthogonal planes at 2,000 n.m. altitude. Provides maximum coverage of USSR with minimum number of satellites.

PROGRAM HISTORY

The MIDAS Program was included in Weapon System 117L when WS 117L was transferred to the Advanced Research Projects Agency. ARPA subsequently separated WS 117L into the DISCOVERER, SAMOS and MIDAS Programs, with the MIDAS objectives based on an infrared reconnaissance system. The MIDAS (Missile Defense Alarm System) Program was directed by ARPA Order No. 38, dated 5 November 1958 until transferred to the Air Force on 17 November 1959. A ten launch development plan for MIDAS (WS-239A) has been approved. Additional authorization has been obtained to utilize two DISCOVERER flights (designated RM-1 and RM-2) to carry background radiometers in support of MIDAS.

attitude,
rbit and

Weapon
nsferred
Agency.
17L into
AS Pro-
ased on
em. The
em) Pro-
No. 38,
erred to
9. A ten
AS (WS-
al author-
two DIS-
nd RM-2)
support



CONDITIONS:
2,000 n.m. altitude
Two orthogonal polar orbital planes, four equi-spaced satellites in each plane.
Readout Stations
United Kingdom
North Atlantic
North Pacific

Figure 4.
Orbiting satellites detect infrared radiation emitted by Soviet ICBM's in powered flight. Data telemetered instantaneously to MIDAS Control Center via far north readout stations. Decoded data reveal approximately the number of missiles launched and launch location, direction of travel and burning characteristics. Probabilities of less than 1.00 on the above map indicate the probability of at least one MIDAS satellite detecting an ICBM launch. Probabilities of 1.00 indicate that more than one MIDAS satellite will always be in position to detect an ICBM launch. These figures are based on geometric considerations of the family of satellites and ground readout station locations.

TECHNICAL HISTORY

The MIDAS infrared reconnaissance payload is engineered to use a standard launch vehicle configuration. This consists of an ATLAS missile as the first stage and the AGENA vehicle, powered by a Bell Aircraft rocket engine as the second, orbiting stage (Figure 1). The final configuration payload weight will be approximately 1,000 pounds.

The first two of the ten R&D flights used the AGENA "A" and ATLAS "D" vehicle programmed to place the payload in a circular 261 nautical mile orbit. Subsequent R&D flights will utilize the ATLAS "D"/AGENA "B" configuration which will be programmed to place the payload in a circular 2,000 nautical mile polar orbit.

MIDAS I, launched in February 1960, did not attain orbit because of a failure during ATLAS/AGENA separation.

MIDAS II, launched in May 1960, was highly successful. Performance with respect to programmed orbital parameters was outstanding. Useful infrared data were observed and recorded.

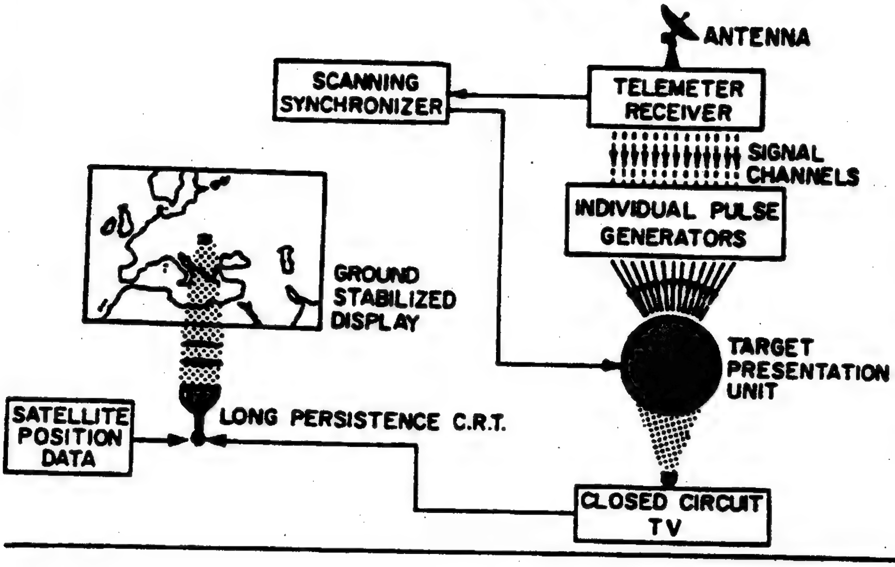
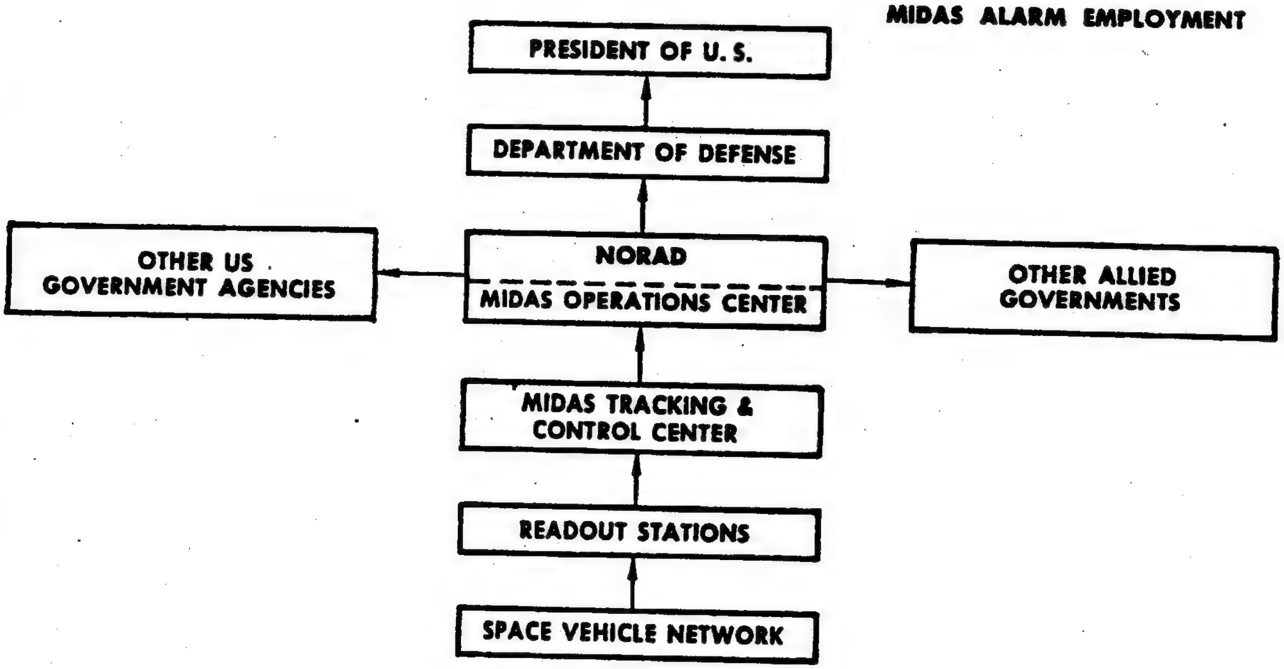


Figure 5. Simplified version of ground presentation system (left) for display of infrared reconnaissance data. The data is displayed on a TV monitor with a map overlay. The chart below shows data flow from the readout stations to decision-making agencies. The MIDAS Control Center, or other using agencies having a correlated ground stabilized display, can determine when an actual attack has been launched.

MIDAS ALARM EMPLOYMENT



CONCEPT

The MIDAS system is designed to provide continuous infrared reconnaissance of the Soviet Union. Surveillance will be conducted by eight satellite vehicles in accurately positioned orbits (Figure 3). The area under surveillance must be in line-of-sight view of the scanning satellite. Mission capabilities are shown in Figure 4. The system is designed to accomplish instantaneous readout of acquired data by at least one of three strategically located readout stations. The readout stations transmit the data directly to the MIDAS Tracking and Control Center where it is processed. It is then displayed and evaluated in the MIDAS Operations Center (Figure 5). If an attack is determined to be underway, the intelligence is communicated to a central Department of Defense Command Post for relay to the President and all national retaliatory and defense agencies.

It is anticipated that assembly of this vehicle will be completed on schedule.

Infrared Scanner Units

Infrared scanner units for flights 3, 4, and 5 are being manufactured by Baird-Atomic, Inc., and for flights 6, 7 and 8 by Aerojet-General Corporation.

- Delivery of the initial Baird-Atomic, Inc., infrared detector payload has been made. This prototype unit is undergoing tests at the Lockheed facility. The flight payload for the third MIDAS launch is now scheduled for delivery in early September. This represents a two week schedule slippage.
- The delivery dates for the two Baird-Atomic, Inc., ground readout units have been established as 8 and 22 September. These schedule slippages, caused by delays during systems tests, will have no effect on flight schedules.

Facilities

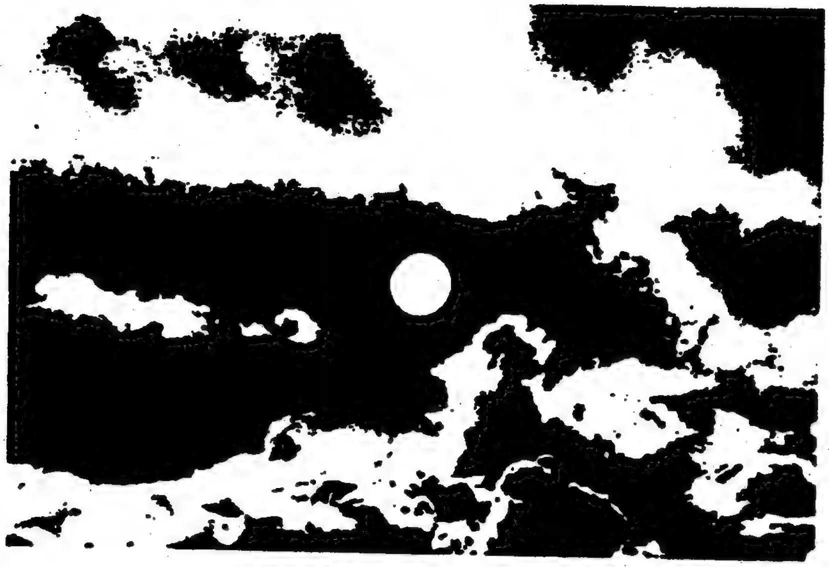
- Authorization has been granted to proceed with the establishment of a satellite tracking station in Africa. The primary function of this station will be to record AGENA "B" second-burn performance data. A portable van installation will be utilized to support the third MIDAS flight scheduled for February. The AMR siting team has selected the location for this station. The design criteria were completed by AFBMD and supplied to AMR during August.
- Completion of facility design criteria for the United Kingdom Readout station is scheduled for October. Design will be initiated by the Third Air Force following receipt of criteria and approval to proceed from Hq USAF and USAFE.
- Initial studies are underway for modification of the New Boston, New Hampshire, data acquisition and processing building to accomodate MIDAS equipment.

AFBMD Activities in Space, Sep 60

[redacted]

SATELLITE
systems

SATELLITE SYSTEMS



DISCOVERER
MIDAS
ADVENT

Discoverer

The DISCOVERER Program consists of the design, development and flight testing of 37 two-stage vehicles, using the THOR IRBM as the first stage booster and the AGENA as the second stage, satellite vehicle. The program was established early in 1958 under direction of the Advanced Research Project's Agency, with technical management assigned to AFBMD. On 14 November 1959, program responsibility was transferred from ARPA to the Air Force by the Secretary of Defense. Prime contractor for the program is Lockheed Missile and Space Division. The DISCOVERER Program will perform space research in support of the advanced military reconnaissance satellite programs.

PROGRAM OBJECTIVES

(a) Flight test of the satellite vehicle airframe, propulsion, guidance and control systems, auxiliary power supply, and telemetry, tracking and command equipment.

(b) Attaining satellite stabilization in orbit.

(c) Obtaining satellite internal thermal environment data.

(d) Testing of techniques for recovery of a capsule ejected from the orbiting satellite.

(e) Testing of ground support equipment and development of personnel proficiency.

(f) Conducting bio-medical experiments with mice and small primates, including injection into orbit, re-entry and recovery.

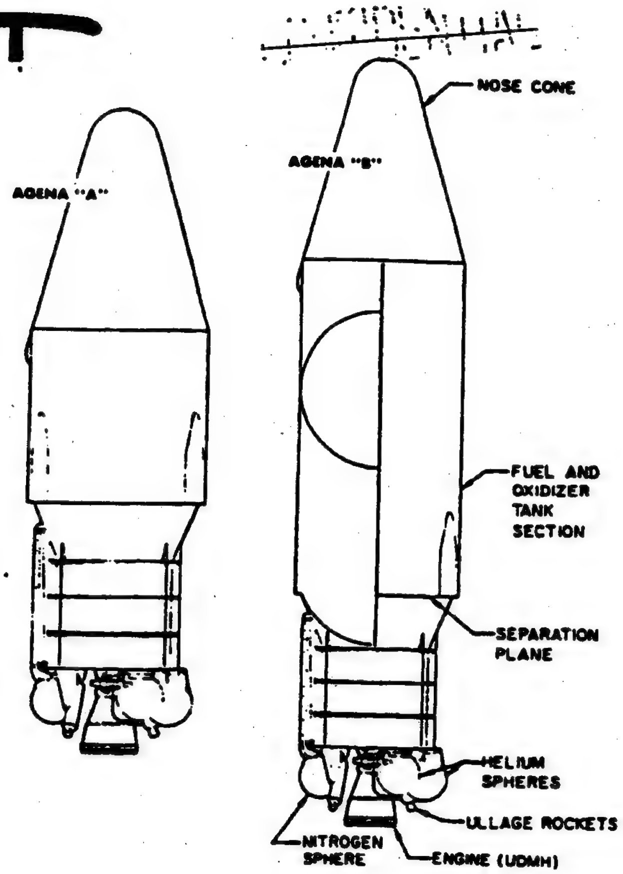
PROGRAM SUMMARY

Early launches confirmed vehicle flight and satellite orbit capabilities, developed system reliability, and established ground support, tracking and data acquisition requirements. Later in the program, biomedical and advanced engineering payloads will be flight tested to obtain support data for more advanced space systems programs. DISCOVERER vehicles are launched from Vandenberg Air Force Base, with overall operational control exercised by the Satellite Test Center, Sunnyvale, California

Tracking and command functions are performed by the stations listed in the Table on page A-4. A history of DISCOVERER flight to date is given on page A-5.

SECOND STAGE	AGENA "A"	AGENA "B"	
Weight—			
Inert	1,262	1,328	1,346
Payload equipment	497	887	915
Orbital	1,759	2,215	2,216
Impulse propellants	6,525	12,950	12,950
Other	378	511	511
TOTAL WEIGHT	8,662	15,676	15,722
Engine Model	YLR81-Ba-5	XLR81-Ba-7	XLR81-Ba-9
Thrust-lbs., vac.	15,600	15,600	16,000
Spec. Imp.-sec., vac.	277	277	290
Burn time-sec.	120	240	240

THOR BOOSTER	DM-18	DM-21
Weight—Dry	6,950	6,500
Fuel	33,700	33,700
Oxidizer (LOX)	68,200	68,200
GROSS WEIGHT (lbs.)	108,850	108,400
Engine	MB-3 Block 1	MB-3 Block 2
Thrust, lbs. (S.L.)	152,000	167,000
Spec. Imp., sec. (S.L.)	247.8	248.3
Burn Time, sec.	163	148



Telemetry ships are positioned as required by the specific mission of each flight. Figures 2 and 3 show a typical launch trajectory from Vandenberg Air Force Base, and figure 3 shows schematically a typical orbit. An additional objective of this program is the development of a controlled re-entry and recovery capability for the payload capsule (Figure 4). An impact area has been established near the Hawaiian Islands, and a recovery force activated. Techniques have been developed for aerial recovery by C-119 aircraft and for sea recovery by Navy surface vessels. The recovery phase of the program has provided advances in re-entry vehicle technology. This information will be used in support of more advanced projects, including the return of a manned satellite from orbit.

FLIGHT VEHICLE

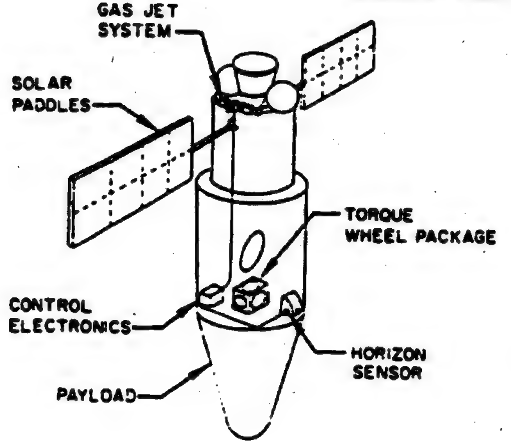
The three versions of flight test vehicles used in the DISCOVERER Program are defined in the launch schedule shown on page A-5. Specifications for the two THOR configurations and three AGENA configurations used are given on page A-1.

AGENA VEHICLE DEVELOPMENT

The AGENA vehicle was originally designed by the Air Force as the basic satellite vehicle for Advanced Military Reconnaissance Satellite Systems Programs. Basic design was based on use of the ATLAS ICBM as the first stage. ATLAS trajectory characteristics and the stringent eccentricity requirements of the advanced programs led to the selection of a guidance system suited to achieving orbital injection in a horizontal attitude. As a result, an optical inertial system was developed for vehicle guidance and a gas jet system for orbital attitude control. An urgent need for attaining higher altitude orbits resulted in development of the AGENA "B" versions. The YLR81 Ba-5 version of the LR81-Ba-3 engine (Bell Hustler engine developed for B-58 aircraft) is used on AGENA "A" vehicles. The YLR81-Ba-5 version of this engine was developed to provide increased performance through the use of unsymmetrical di-methyl hydrazine (UDMH) fuel instead of JP-4.

Early AGENA "B" vehicles will use the YLR81-Ba-7 version of this engine. The majority of AGENA "B" vehicles will use the XLR81-Ba-9 engine incorporating a nozzle expansion ratio of 45:1, and providing a further increase in performance capability including engine restart and extended burn capability.

SAMOS and MIDAS AGENA VEHICLE



DISCOVERER/AGENA

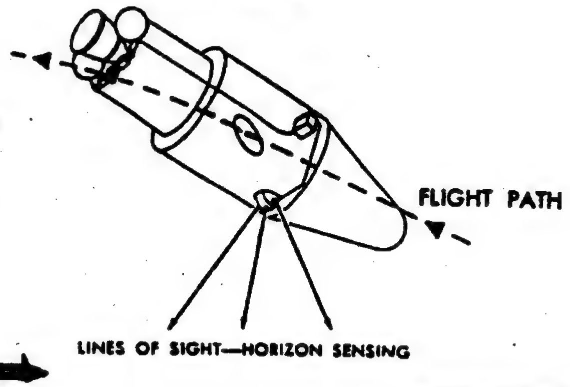
PERFORMANCE CAPABILITIES

ALTITUDE

200–20,000 MILES

ATTITUDE

ROLL – 0 1 DEGREE
PITCH – 0 1 DEGREE
YAW – 1 DEGREE



CONE

FUEL AND
OXIDIZER
TANK
SECTION

EPARATION
ANE

IUM
HERES

GE ROCKETS

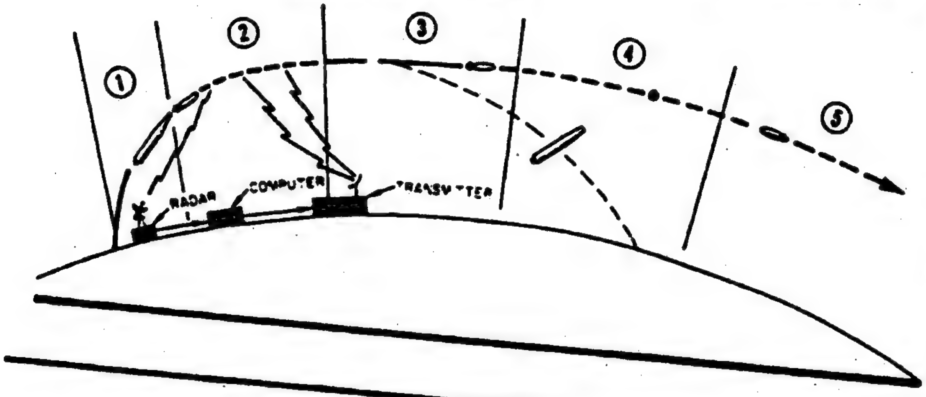
JOMH)

gent
d in
.R81
stler
on
this
orm-
ethyl

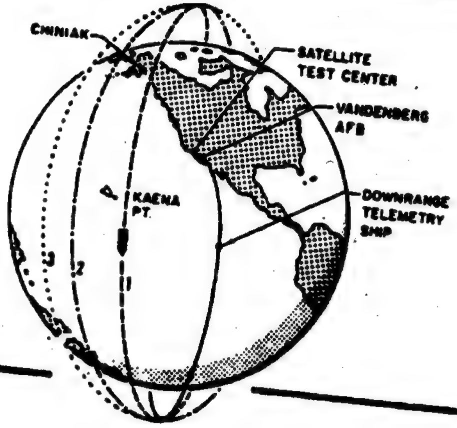
Ba-7
"B"
sting
ng a
ding

HT PATH

Powered Flight Trajectory



1. **First Stage Powered**
duration, 78 n.m. downrar
grammed auto pilot.
2. **Coast Period**—2.4 min
n.m. downrange; altitude
tial reference package, ho
reaction jets. Receives AGE
velocity to be gained comm
3. **Second Stage Powered**
duration, to 770 n.m. downr
controlled by inertial referer
zon scanner, gas reaction je
engine, yaw and pitch acc
grated.
4. **Vehicle Reorients to Nose**
duration, to 2,000 n.m. downrc
attitude controlled by inertial
age, horizon scanner and gas
5. **In-Orbit**—Controlled (sam

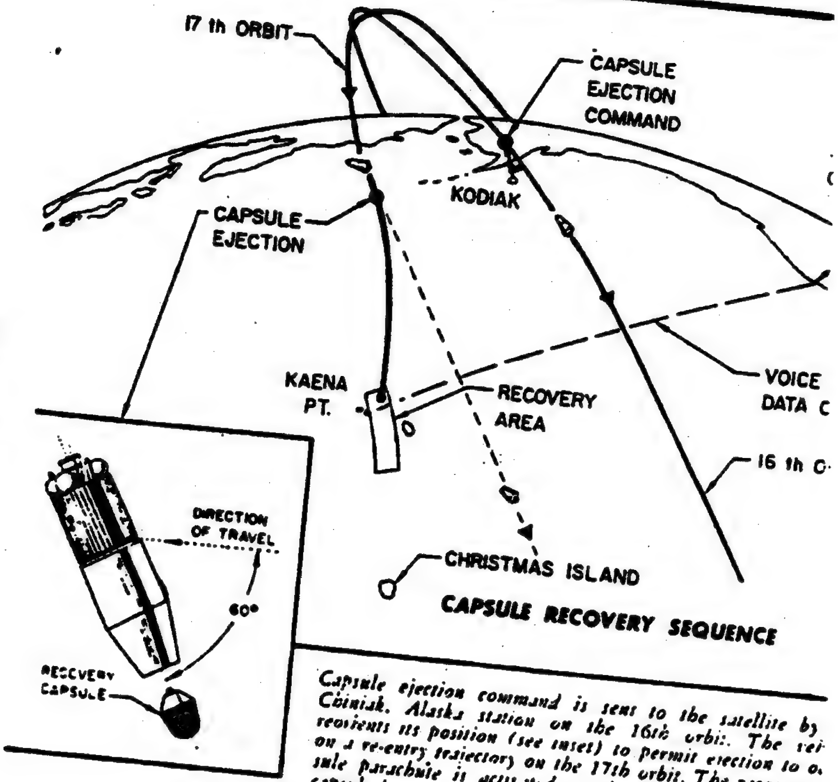


Orbital Trajectory

Schematic presentation of orbital trajectory following launch from Vandenberg Air Force Base. Functions performed by each station and a listing of equipment used by each station, is given on page A-4.

RECOVERY CAPABILITY

This objective was added to the program after the first launch achieved vehicle flight and orbit objectives successfully. It includes the orientation of the satellite vehicle to permit a recoverable capsule to be ejected from the nose section of the AGENA vehicle. Ejection is programmed to occur on command on the 17th orbit, for capsule impact within the predetermined recovery area south of Hawaii. Aircraft and surface vessels are deployed within the area as a recovery force.



CAPSULE RECOVERY SEQUENCE

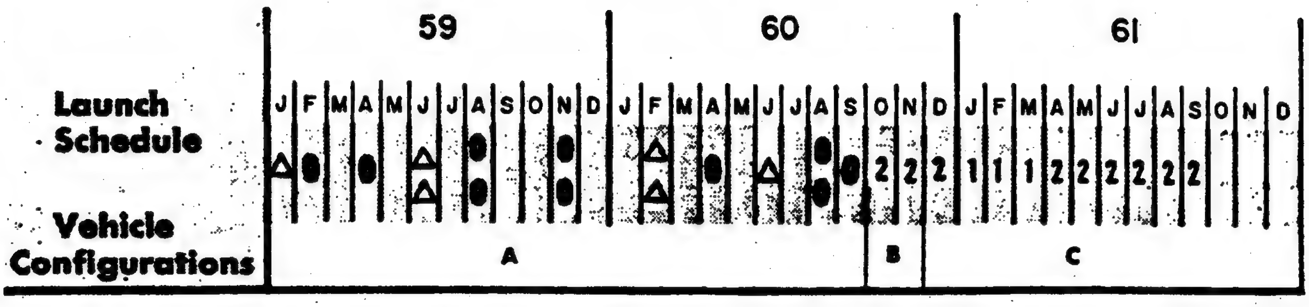
*Capsule ejection command is sent to the satellite by
Chiniak, Alaska station on the 16th orbit. The vei
reorients its position (see inset) to permit ejection to o
on a re-entry trajectory on the 17th orbit. The recovery c
sule parachute is actuated at about 50.000 feet, and
capsule beacon transmits a radio signal for tracking purpo
The recovery force is deployed in the recovery (impact) ar*

GROUND SUPPORT FACILITIES

Facility	Equipment*	Flight Function
Satellite Test Center	A	Over-all control, convert tracking stations data to obtain a predicted orbit and generate subsequent ephemerides issue acquisition data to tracking stations for subsequent passes, predict recovery data.
Vandenberg AFB	BCDEFGHIJK	Launch, ascent and orbital tracking, telemetry reception, trajectory measurements including time to ignite second stage.
Point Mugu	BCDEFGHIJKL	Ascent tracking and telemetry data reception, transmits command to ignite and shut down AGENA (via guidance computer).
Telemetry Ship (Pvt. Joe E. Mann)	DF	Final stage ascent tracking and telemetry data reception.
New Boston, New Hampshire (tracking station)	BDEFGHIJK	Orbital tracking and telemetry data reception.
Kodiak, Alaska (tracking station)	BDEFGHIJK	Orbital tracking and telemetry data reception, including first pass acquisition, recovery capsule ejection and impact prediction.
Kaena Point, Oahu, Hawaii (tracking station)	BCDEFGHIJK	Orbital tracking and telemetry data reception.
Hickam AFB Oahu, Hawaii		Over-all direction of capsule recovery operations.

Equipment

A. 2 UNIVAC 1103-A digital computers
B VERLORT (Modified Mod II) radar
C. TLM-18 self-tracking telemetering antenna
D. Tri-helix antenna
E. Doppler range detection equipment
F. Telemetry tape recording equipment
G. Telemetry decommutators for real time data presentation
H. Plot boards for radar and TLM-18 tracking data
I. Conversion equipment for teletype transmission of radar, TLM-18 and doppler tracking data in binary format
J. Acquisition programmer for pre-acquisition direction of antennas
K. Ground command to satellite transmission equipment
L. Guidance computer



A. THOR—DM-18 / AGENA "A"

B. THOR—DM-21 MB-3 Block 1 / AGENA "B" XLR81-Ba-7

C. THOR—DM-21 MB-3 Block 2 / AGENA "B" XLR81-Ba-9

● Attained orbit successfully.

△ Failed to attain orbit.

Flight History

DISCOVERER No.	AGENA No.	THOR No.	Flight Date	Remarks
0	1019	160	21 January 1959	*AGENA destroyed by malfunction on pad. THOR refurbished for use on flight XII.*
I	1022	163	28 February	*Attained orbit successfully. Telemetry received for 514 seconds after lift-off.*
II	1018	170	13 April	*Attained orbit successfully. Recovery capsule ejected on 17th orbit was not recovered. All objectives except recovery successfully achieved.*
III	1020	174	3 June	*Launch, ascent, separation, coast and orbital boost successful. Failed to achieve orbit because of low performance of satellite engine.*
IV	1023	179	25 June	*Same as DISCOVERER III.*
V	1029	192	13 August	*All objectives successfully achieved except capsule recovery after ejection on 17th orbit.*
VI	1028	200	19 August	*Same as DISCOVERER V.*
VII	1051	206	7 November	*Attained orbit successfully. Lack of 400-cycle power prevented stabilization on orbit and recovery.*
VIII	1050	212	20 November	*Attained orbit successfully. Malfunction prevented AGENA engine shutdown at desired orbital velocity. Recovery capsule ejected but not recovered.*
IX	1052	218	4 February 1960	*THOR shut down prematurely. Umbilical cord mast did not retract. Quick disconnect failed, causing loss of helium pressure.*
X	1054	223	19 February	*THOR destroyed at T plus 56 sec. by Range Safety Officer.*
XI	1055	234	15 April	*Attained orbit successfully. Recovery capsule ejected on 17th orbit was not recovered. All objectives except recovery successfully. achieved.*
XII	1053	160	29 June	*Launch. ascent. separation, coast and orbital stage ignition were successful. Failed to achieve orbit because of AGENA attitude during orbital stage boost.*
XIII	1057	231	10 August	*Attained orbit successfully. Recovery capsule ejected on 17th orbit. Capsule was recovered after a water impact with negligible damage. All objectives except the airborne recovery were successfully achieved.*
XIV	1056	237	18 August	*Attained orbit successfully. Recovery capsule ejected on the 17th orbit and was successfully recovered by the airborne force. All objectives successfully achieved.*
XV	1058	246	13 September	*Attained orbit successfully. Ejection and recovery sequence were normal. Capsule impact occurred south of the recovery forces: located but lost prior to being retrieved.*

DISCOVERER XV

- DISCOVERER XV was launched from Vandenberg Air Force Base at 1515 PDT on 13 September and was successfully injected into polar orbit. Two-thirds of the satellites launched in the DISCOVERER Program have attained orbit. THOR booster trajectory was satistfactory; AGENA performance was nominal. Propellant exhaustion caused shutdown, rather than integrator command. A comparison of programmed and actual orbital parameters is shown in Table I.

PARAMETER	NOMINAL	ACTUAL
Azimuth, degree	172.0	175.2
Perigee, statute miles	120	129
Apogee, statute miles	410	478
Injection Angle	0	−0.2
Eccentricity	0.0371	0.04
Period, minutes	93.44	94.2

TABLE I. DISCOVERER XV Programmed Orbital Parameters

- Data received on the first pass over Kodiak and Hawaii indicated that the satellite was stable and in correct attitude but that control gas consumption was excessive. The capsule was ejected on the 17th orbit but, because of a loss of control gas, the pitch-down prior to ejection was not accomplished. As a result, the capsule impacted about 1,000 miles south of the impact point predicted prior to capsule ejection. Subsequent analysis indicates that the roll rate gyro was not properly restraining the rate of satellite roll movements to the proper frequency. This caused the satellite to roll between limits faster than normal and resulted in higher than normal control gas expenditure.

- The capsule descent was tracked by the Hawaiian tracking station until re-entry; a computer run of this data resulted in a revised impact point prediction. Aircraft and the recovery ship "Dalton Victory" were dispatched to the impact area. The first aircraft to reach the area located the capsule by radio beacon at 2105 PDT and a second aircraft sighted it thirty minutes later. Marker beacons, strobe lights, smoke bombs and aluminum dye were dropped to mark the area. On the morning of the 15th, a Coast Guard amphibian arrived but did not land because of rough seas. Because of deteriorating weather and sea conditions, a plan to drop parachutists and a raft was abandoned.

- At 1115 PDT on 15 September electronic contact was lost. Fifteen minutes later, the aircraft lost sight of the capsule which was then listing and riding low in the water. The capsule was not seen again although the search continued throughout 15 and 16 September.

DISCOVERER XVI

- DISCOVERER XVI is scheduled for launch from Vandenberg Air Force Base in October. This will be the first AGENA "B" vehicle to be launched. Vehicle subsystem and system checks were completed during September and the vehicle has been installed on the launch pad. The AGENA "B" is an improved version of the AGENA "A" containing integral propellant tanks which form part of the satellite skin and having double the propellant capacity.

- The increased payload capability of the AGENA "B" will permit use of extra batteries and control gas required for two, three and four day intervals between launch and capsule recovery. The recoverable payload is similar to those flown on DISCOVERER XIV and XV. The ascent parameters for AGENA "B" DISCOVERER satellites are markedly different from previous DISCOVERER vehicles. A comparison of predicted parameters for DISCOVERER XV and DISCOVERER XVI are shown in Table II.

	DISCOVERER XV (AGENA "A")	DISCOVERER XVI (AGENA "B")
ASCENT PARAMETERS		
THOR Burnout Time, seconds from liftoff	163	163
THOR Velocity at Burnout, fps	13,660	10,610
AGENA Ignition Time, seconds from liftoff	269	237
AGENA Burn Time, seconds	117	240
Injection Velocity, fps	26,032	25,964
ORBITAL PARAMETERS		
Apogee, statute miles	410	426
Perigee, statute miles	120	130
Eccentricity	0.0371	0.035
Inclination Angle, degree	79.63	81.83
Period, minutes	93.44	93.5

TABLE II. Comparison of Ascent and Orbital Parameters for AGENA "A" and AGENA "B" Satellites

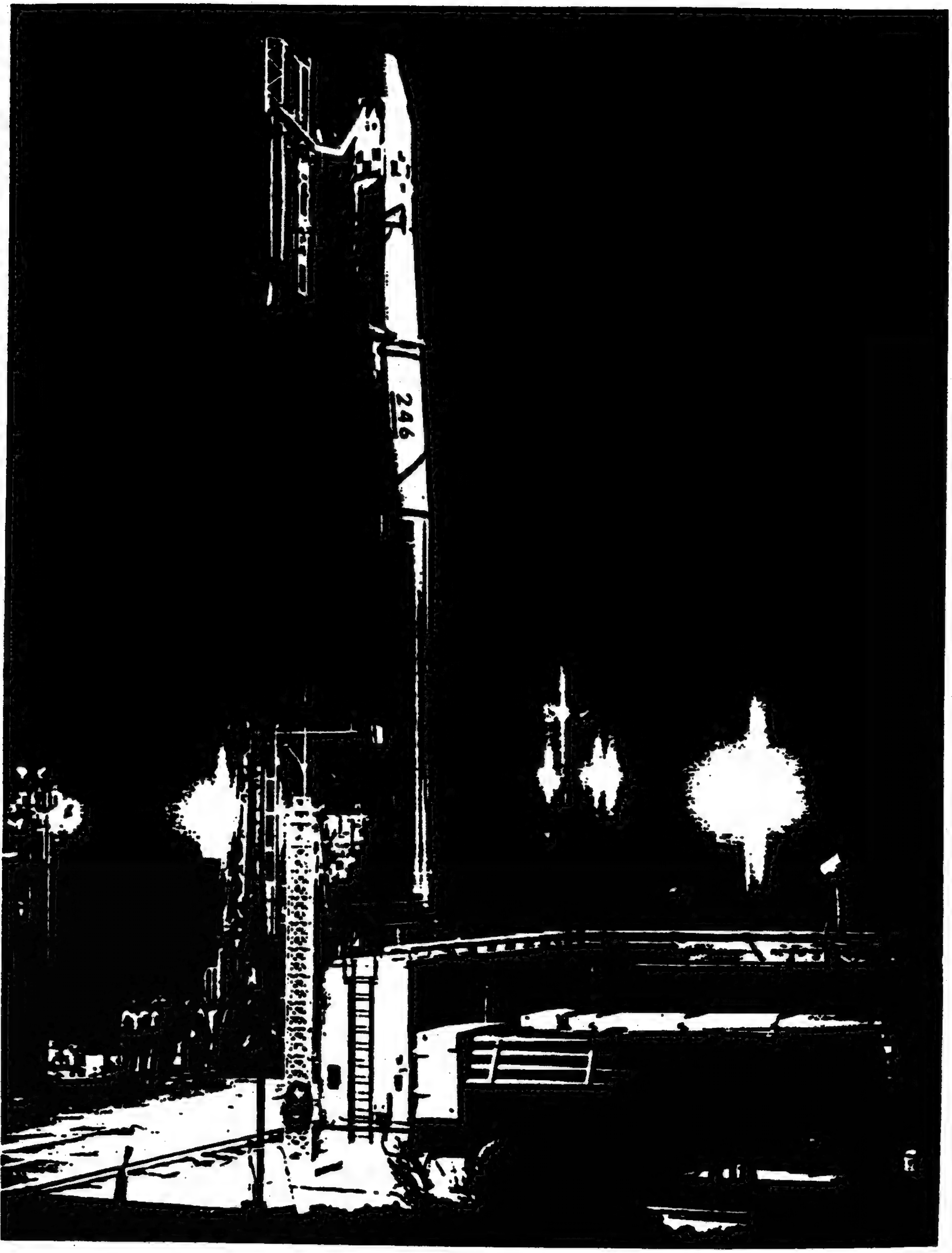


Figure [illegible] DISCOVERER XV prior to launch on 13 September. The main- [illegible] THOR booster is [illegible] for launch. The [illegible] right background. The two nitrogen storage [illegible] and the [illegible] trailer are shown on the right.

Technical Progress

Second Stage Vehicles

- The results of an investigation into system and equipment performance on DISCOVERER XV were presented on 20 September. The presentation included analysis of the various problem areas encountered; action taken to improve test procedures, inspections and equipment specifications; and action to incorporate improvements in DISCOVERER XVI.
- The XLR-81Ba-9 engine (serial No. 307) was fitted with a new thrust chamber and subjected to a full duration calibration run. The 240 second firing was completed without appreciable nozzle throat erosion, using a titanium uncooled extension which had previously completed a five day humidity test. The nozzle extension was in excellent condition following the firing. This test completed the Preliminary Flight Rating Test for this engine which is now being prepared for re-acceptance inspection prior to shipment to Arnold Engineering Development Center for reliability testing.

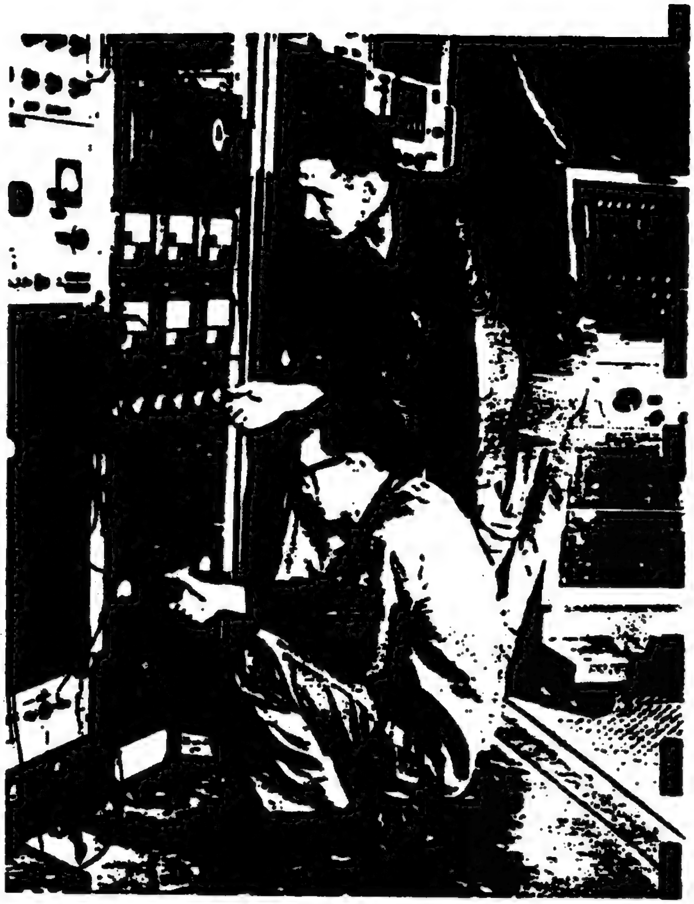


Figure 2. Air Force technicians adjusting electronic checkout equipment during flight control checkout of an AGENA vehicle. This activity is taking place in the Vandenberg Air Force Base missile assembly building.

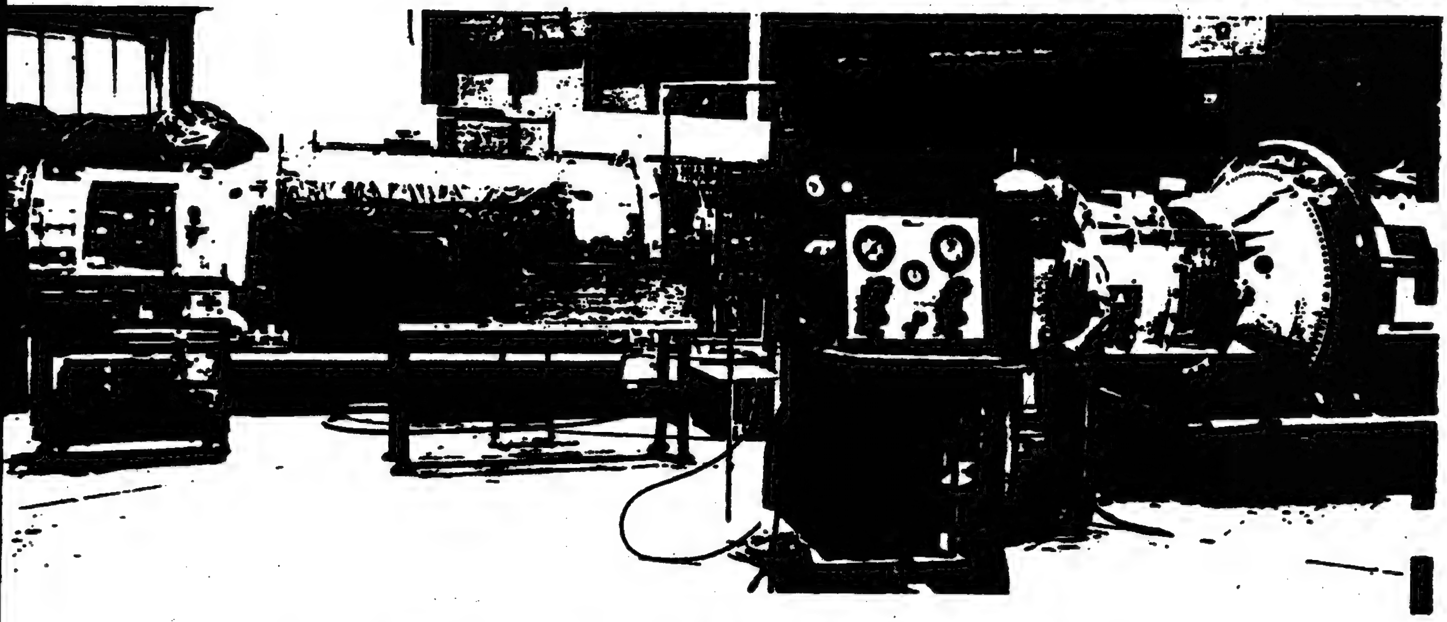
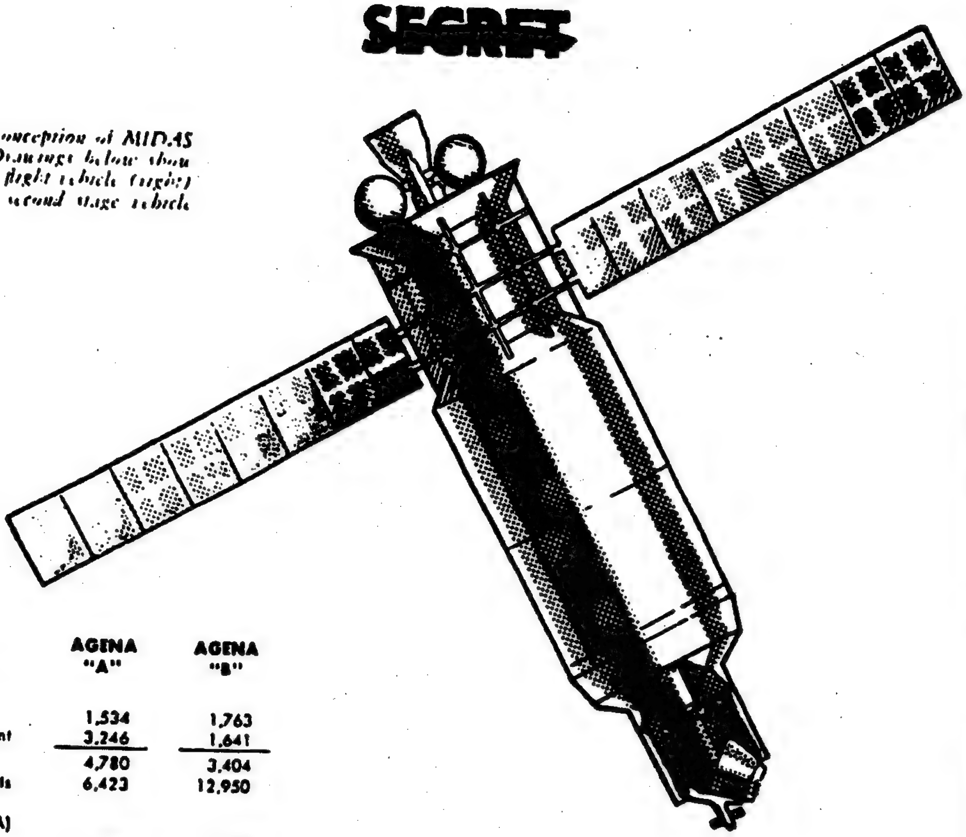


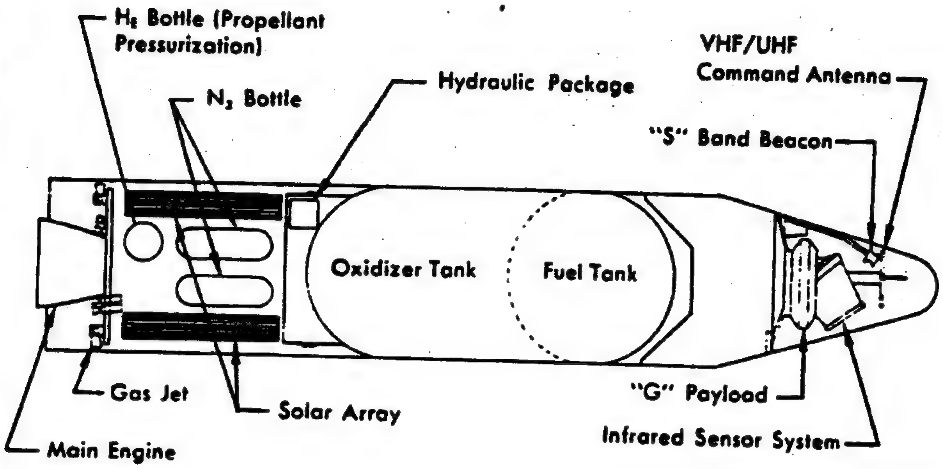
Figure 3. Change-over from AGENA "A" to AGENA "B" in the missile assembly building at Vandenberg Air Force Base. The AGENA "A" on the right, is DISCOVERER XV which was launched on 13 September. One more AGENA "A" remains to be flown. On the left is the AGENA "B" vehicle scheduled for launch in October as DISCOVERER XVI.

Figure 1. Artist's conception of MIDAS satellite (right). Drawings below show complete two-stage flight vehicle (right) and AGENA "B" second stage vehicle (left).



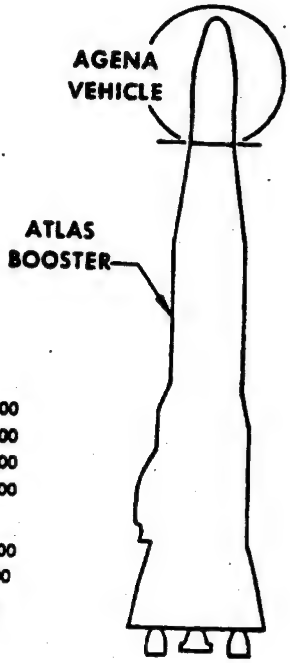
M i d a s

SECOND STAGE	AGENA "A"	AGENA "B"
Weight—		
Inert	1,534	1,763
Payload equipment	3,246	1,641
Orbital	4,780	3,404
Impulse Propellants	6,423	12,950
Fuel (UDMH)		
Oxidizer (IRFNA)		
Other	606	758
GROSS WEIGHT (lbs.)	11,809	17,112
Engine	YLR81-Ba-5	XLR81-Ba-9
Thrust, lbs. (vac.)	15,600	16,000
Spec. Imp., sec. (vac.)	277	290
Burn Time, sec.	120	240
Restart Provisions	No	Yes



MIDAS, Configuration II, AGENA "B" Satellite

BOOSTER—ATLAS ICBM		
Weight—Wet		15,100
Fuel, RP-1		74,900
Oxidizer (LOX)		172,300
GROSS WEIGHT (lbs.)		262,300
Engine—MA-2		
Thrust (lbs. vac.)	Boost	356,000
	Sustainer	82,100
Spec. Imp. (sec. vac.)	Boost	286
	Sustainer	310



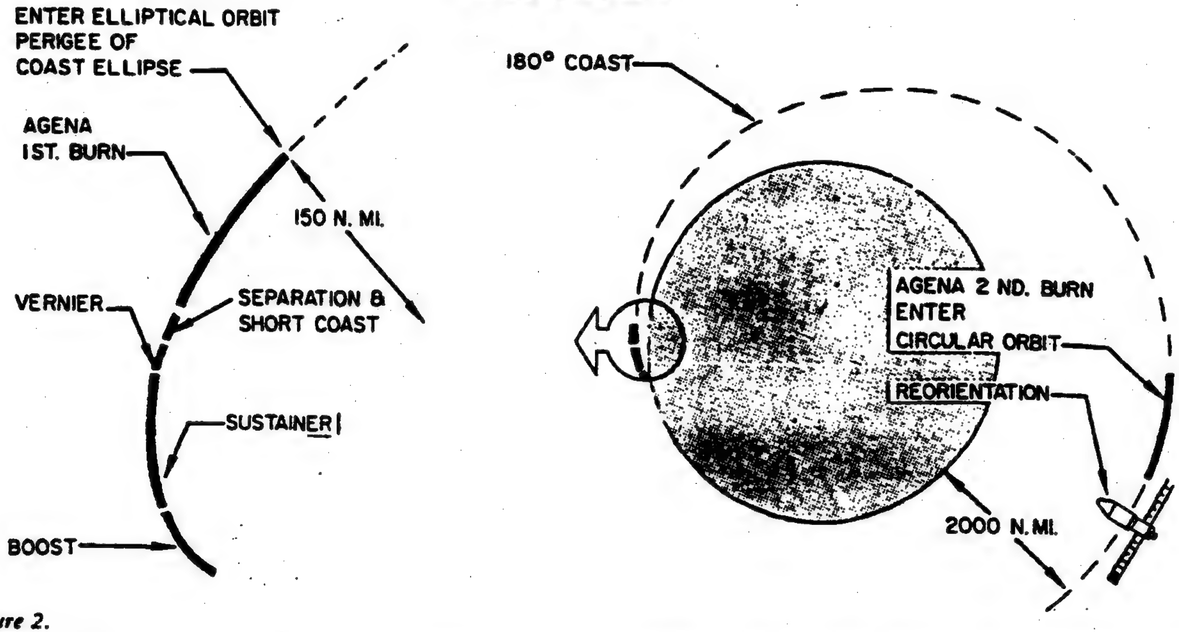


Figure 2.
Launch-to-orbit trajectory for flights 3 and subsequent. From boost through separation guidance and control is provided by the ATLAS radio inertial system. The AGENA inertial guidance system, with horizon scanner, provides attitude, velocity and directional control to establish the orbit and vehicle orientation.

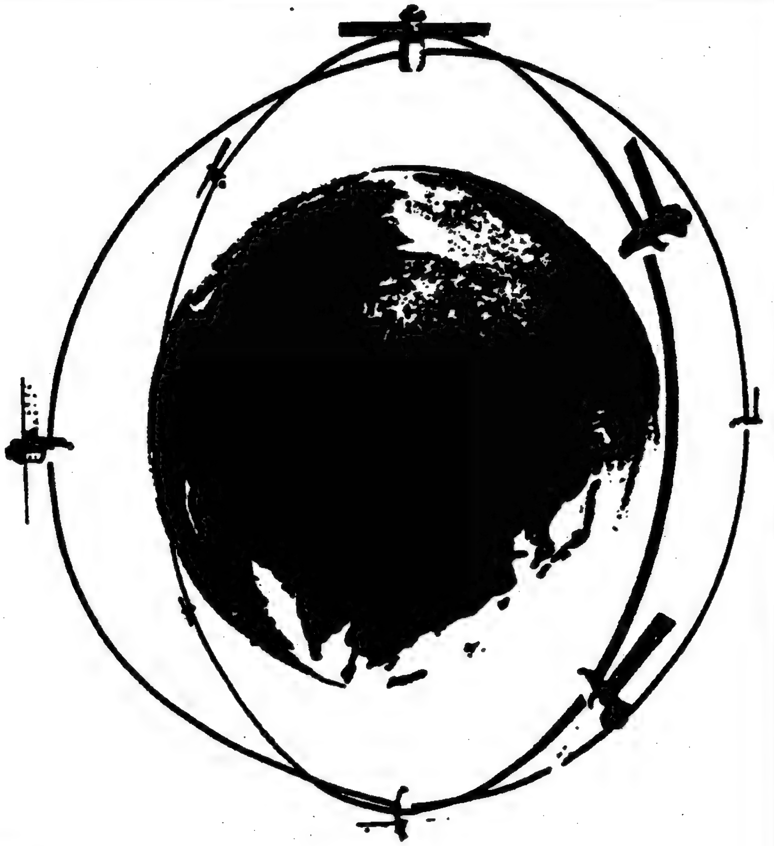
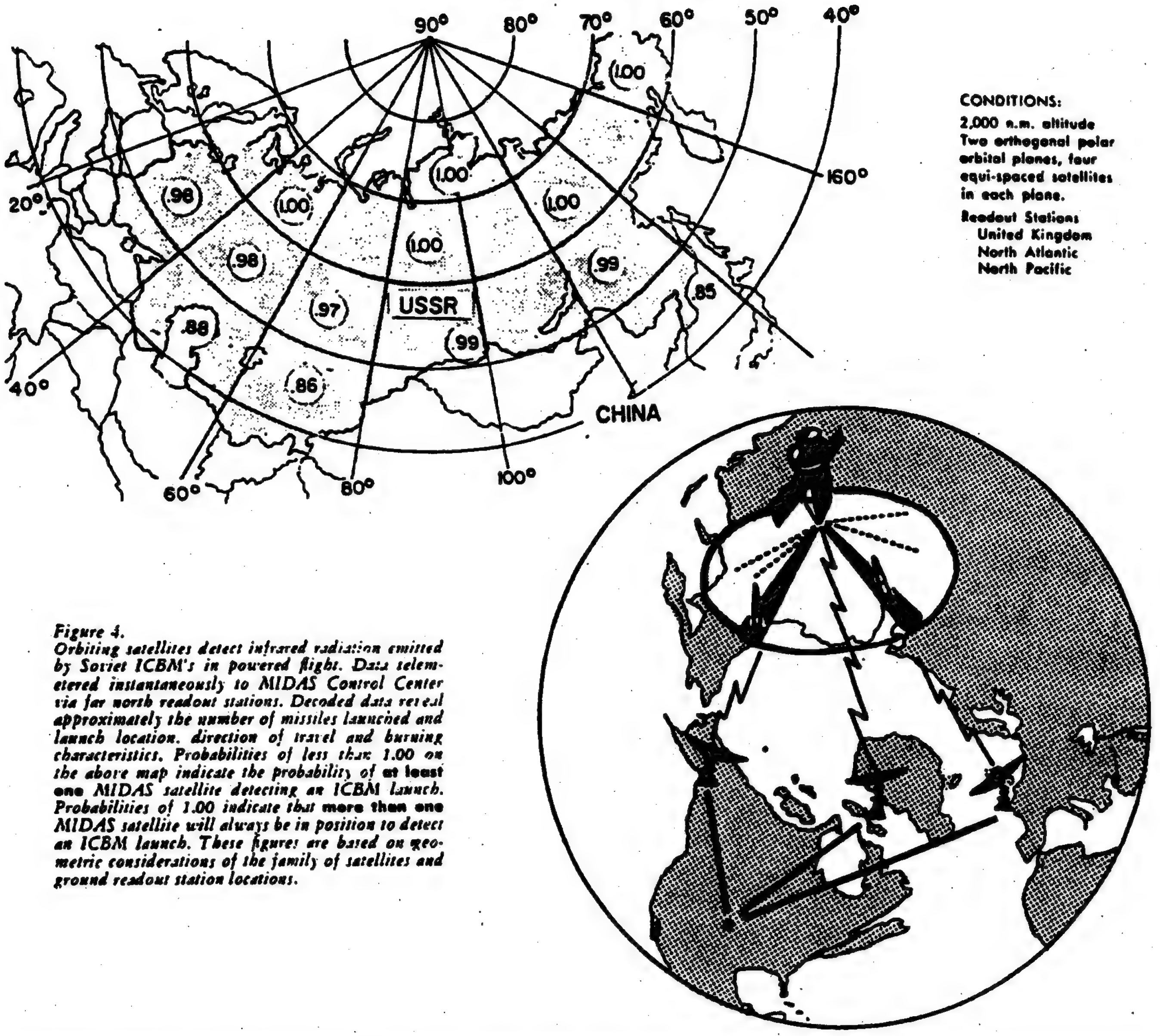


Figure 3.
Proposed MIDAS system. Four satellites spaced equidistant in each of two orthogonal planes at 2,000 n.m. altitude. Provides maximum coverage of USSR with minimum number of satellites.

PROGRAM HISTORY

The MIDAS Program was included in Weapon System 117L when WS 117L was transferred to the Advanced Research Projects Agency. ARPA subsequently separated WS 117L into the DISCOVERER, SAMOS and MIDAS Programs, with the MIDAS objectives based on an infrared reconnaissance system. The MIDAS (Missile Defense Alarm System) Program was directed by ARPA Order No. 38, dated 5 November 1958 until transferred to the Air Force on 17 November 1959. A ten launch development plan for MIDAS (WS-239A) has been approved. Additional authorization has been obtained to utilize two DISCOVERER flights (designated RM-1 and RM-2) to carry background radiometers in support of MIDAS.



CONDITIONS:
2,000 n.m. altitude
Two orthogonal polar orbital planes, four equi-spaced satellites in each plane.
Readout Stations:
United Kingdom
North Atlantic
North Pacific

attitude,
rbit and

Figure 4.
Orbiting satellites detect infrared radiation emitted by Soviet ICBM's in powered flight. Data telemetered instantaneously to MIDAS Control Center via far north readout stations. Decoded data reveal approximately the number of missiles launched and launch location, direction of travel and burning characteristics. Probabilities of less than 1.00 on the above map indicate the probability of **at least one** *MIDAS satellite detecting an ICBM launch. Probabilities of 1.00 indicate that* **more than one** *MIDAS satellite will always be in position to detect an ICBM launch. These figures are based on geometric considerations of the family of satellites and ground readout station locations.*

Weapon
nsferred
Agency.
17L into
AS Pro-
ased on
em. The
em) Pro-
No. 38,
erred to
9. A ten
AS (WS-
al author-
two DIS-
nd RM-2)
support

TECHNICAL HISTORY

The MIDAS infrared reconnaissance payload is engineered to use a standard launch vehicle configuration. This consists of an ATLAS missile as the first stage and the AGENA vehicle, powered by a Bell Aircraft rocket engine as the second, orbiting stage (Figure 1). The final configuration payload weight will be approximately 1,000 pounds.

The first two of the ten R&D flights used the AGENA "A" and ATLAS "D" vehicle programmed to place the payload in a circular 261 nautical mile orbit. Subsequent R&D flights will utilize the ATLAS "D"/AGENA "B" configuration which will be programmed to place the payload in a circular 2,000 nautical mile polar orbit.

MIDAS I, launched in February 1960, did not attain orbit because of a failure during ATLAS/AGENA separation.

MIDAS II, launched in May 1960, was highly successful. Performance with respect to programmed orbital parameters was outstanding. Useful infrared data were observed and recorded.

~~CONFIDENTIAL~~

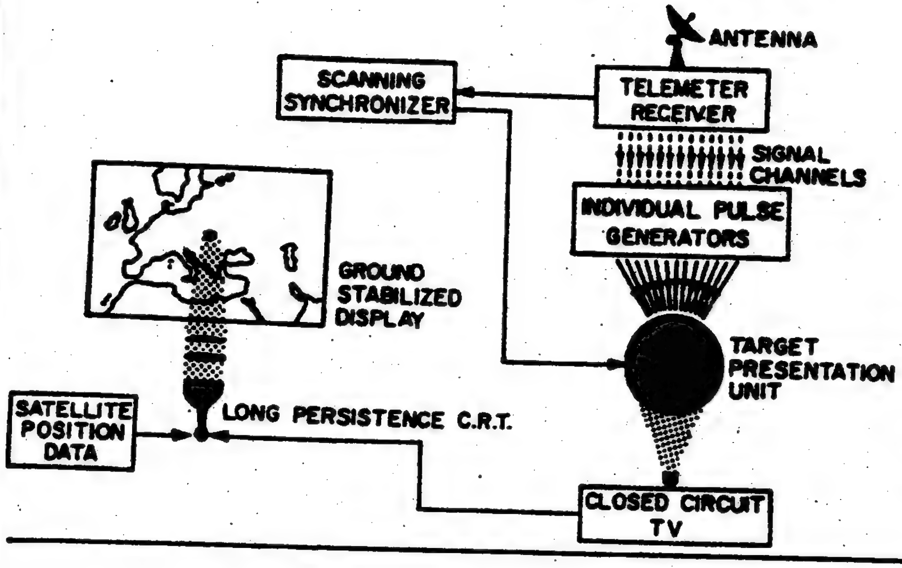
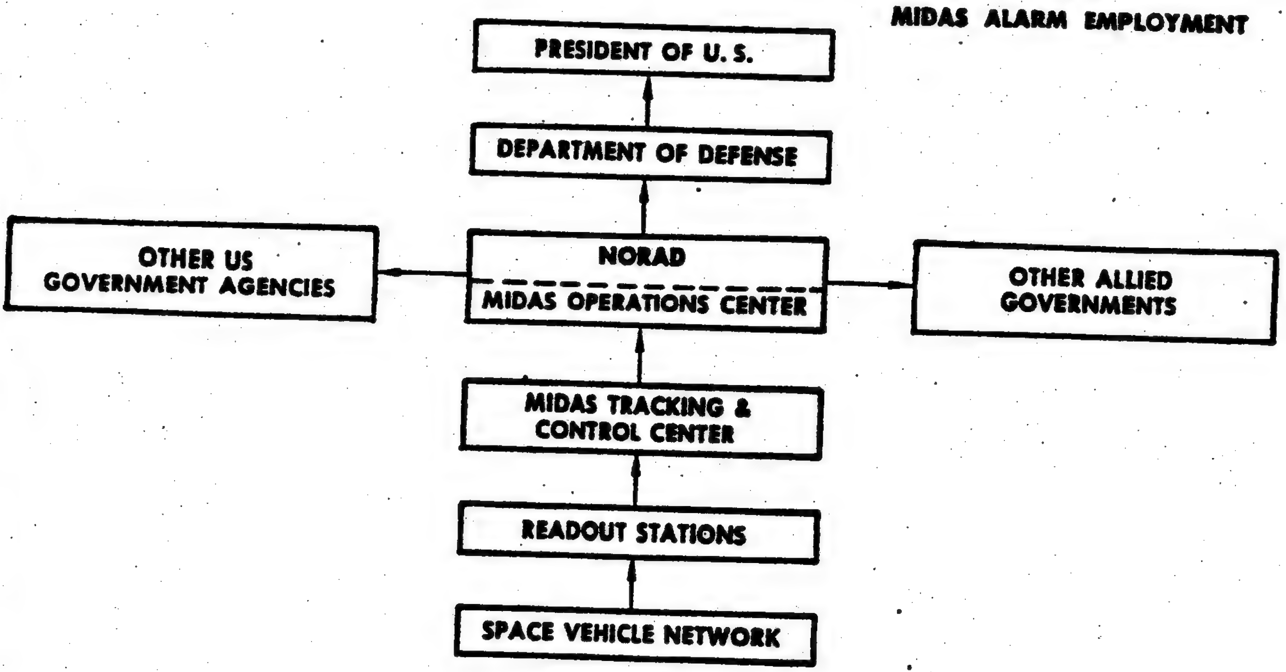


Figure 5.
Simplified version of ground presentation system (left) for display of infrared reconnaissance data. The data is displayed on a TV monitor with a map overlay. The chart below shows data flow from the readout stations to decision-making agencies. The MIDAS Control Center, or other using agencies having a correlated ground stabilized display, can determine when an actual attack has been launched.



MIDAS ALARM EMPLOYMENT

CONCEPT

The MIDAS system is designed to provide continuous infrared reconnaissance of the Soviet Union. Surveillance will be conducted by eight satellite vehicles in accurately positioned orbits (Figure 3). The area under surveillance must be in line-of-sight view of the scanning satellite. Mission capabilities are shown in Figure 4. The system is designed to accomplish instantaneous readout of acquired data by at least one of three strategically located readout stations. The readout stations transmit the data directly to the MIDAS Tracking and Control Center where it is processed. It is then displayed and evaluated in the MIDAS Operations Center (Figure 5). If an attack is determined to be underway, the intelligence is communicated to a central Department of Defense Command Post for relay to the President and all national retaliatory and defense agencies.

	60												61												62											
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
		1			1									1		1		1				1			1		1		1		1					
VEHICLE CONFIGURATIONS	ATLAS "D"/AGENA "A"												ATLAS "D"/AGENA "B"																							

MIDAS Launch Schedule

Facility	*Equipment**	*Flight Function*
Satellite Test Center	ABC	Operations control center of the system during the R&D program. Directs tracking station operations, controls satellite programming and communication system utilization. Receives and stores key vehicle and station data, determines vehicles ephemerides and generates acquisition and tracking data to tracking stations. Analyzes systems operation and telemetry and payload data.
Vandenberg Air Force Base (tracking and data acquisition station)	ABCEFGHIJKLMPTU	Provides launch and ascent tracking, receives and records telemetry data and trajectory measurements. Gathers payload data, telemetry and tracking data and transmits this data to the Satellite Test Center.
Telemetry ships	IKMS	Ascent tracking and telemetry data reception through AGENA first burn period.
Vandenberg AFB	NO	Provides ground radio guidance system for booster guidance during the launch phase.
Northeast Station (New Boston, New Hampshire)	CDEFHMPQR	Provides orbital tracking. Gathers payload data, telemetry and tracking data and transmits this data to the Satellite Test Center.
Southeast Africa Station	JKM	To receive and record telemetry data and provide limited tracking during the AGENA second burn period.
Kaena Point, Oahu, Hawaii	HIKLMTU	Gathers supplemental Verlort tracking data during orbital passes.
Kodiak, Alaska	HIKLMTU	Gathers supplemental Verlort tracking data during orbital passes.
Point Mugu	HI	Ascent tracking for range safety; backup function.
Point Arguello	V	Mates vehicles, performs final system checkout, prepares vehicle for launch and launches vehicle.

**Equipment*

A. Model 1604 Computer
B. Ground Presentation Equipment
C. Data Distribution Equipment (PICE)
D. Data Conversion Equipment
E. UHF Tracking Equipment
F. UHF Telemetry and Data Acquisition Equipment
G. UHF Command Antenna
H. VERLORT (Mod II) Radar
I. Tri-helix Antenna
J. TLM-18 Telemetry Antenna
K Telemetry Receiving and Recording Equipment
L. Plot Boards for Radar and TLM-18 Tracking Data
M. Doppler Data Gathering Equipment
N. AN/GQR-2 (XXA-2) Tracking and Monopulse Radar
O. AN/GRS-2 (XAA-2) Rate Measuring System
P. Timing (WWV) Equipment
Q. VHF FM/FM Data Acquisition Equipment
R. VHF PAM/FM Data Acquisition Equipment
S. High Frequency Radio Communications and Teletype Circuits
T. Acquisition Programmer for pre-acquisition Direction of Antennas
U. Conversion Equipment for Teletype Transmission of Radar, TLM-18 and Doppler Tracking Data in Binary Format
V. Complete Launch Facilities

GROUND SUPPORT FACILITIES

MONTHLY PROGRESS — MIDAS Program

Program Administration

- As a result of recent investigations by Space Technology Laboratories on the significance of the high energy tail of Van Allen protons, and their potential effect on long-life satellites, Lockheed has been requested to develop special instrumentation to be carried on MIDAS flights. Contrary to the present theory that the damage cross section is inversely proportional to energy, evidence has been found that solar photovoltaic cells may be degraded at a much higher rate by high energy protons, e.g., 700 MEV. A comprehensive program has been initiated to determine the sensitivity of selected components to high energy proton radiation and to determine the quantitative and qualitative characteristics of the Van Allen radiation at MIDAS flight altitudes.

Flight Test Progress

- The vehicle for the third MIDAS flight is currently in the systems test phase of checkout. This is the first MIDAS vehicle to have restart capability. Because of problems which developed in the horizon sensor and related checkout equipment, this vehicle is behind schedule. Based on delivery of a reworked horizon sensor on 15 October, it is scheduled to complete the systems test phase on 12 December. The scheduled launch date for this flight remains 28 February 1961.

Technical Progress

Second Stage Vehicles

- Assembly of the AGENA "B" vehicles for the fourth and fifth MIDAS flights is proceeding on schedule. The vehicle scheduled for the fourth MIDAS flight is now in final assembly.

Infrared Scanner Units

Infrared scanner units for flights 3, 4 and 5 are being manufactured by Baird-Atomic, Inc., and for flights 6, 7 and 8 by Aerojet-General Corporation.

- The infrared detector payload scheduled to be carried on the third MIDAS flight has been delivered. Acceptance testing of this payload will be completed in early October. The second flight payload is scheduled for delivery on 15 October. Two more payloads, one for backup purposes, remain to be delivered.

- Temperature profile tests of the engineering test model of the Baird-Atomic configuration are in progress in the High Altitude Temperature Simulation Chamber.

Ground Support Equipment

- Delivery of the initial Baird-Atomic ground infrared data display equipment is scheduled for 15

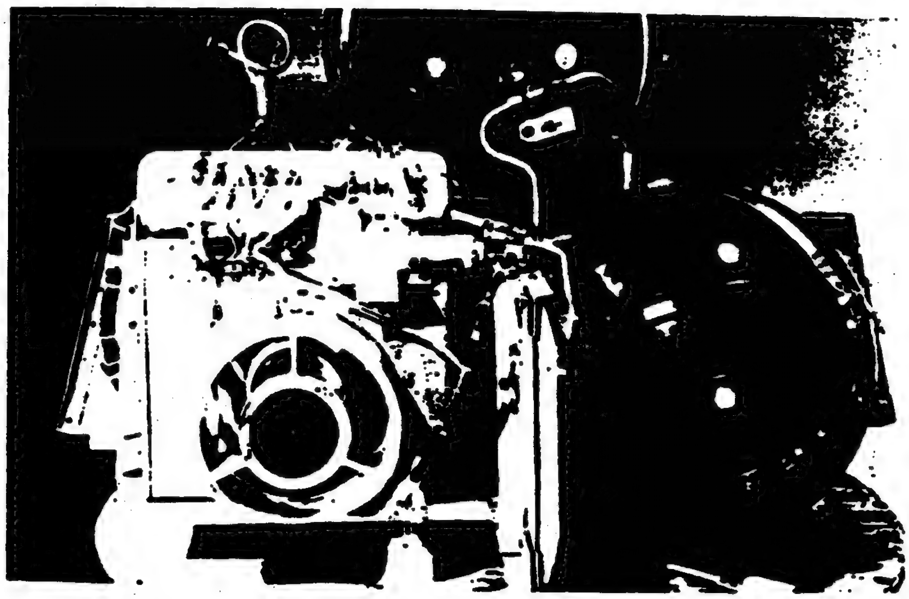


Figure 6. A background radiometer of the type to be carried on DISCOVERER flights RM-1 and RM-2. The primary function of these flights will be to provide background radiation data for use in future MIDAS flights. The nitrogen spheres are part of the nitrogen-gas cooling system which cools the sensitive element of the radiometer.

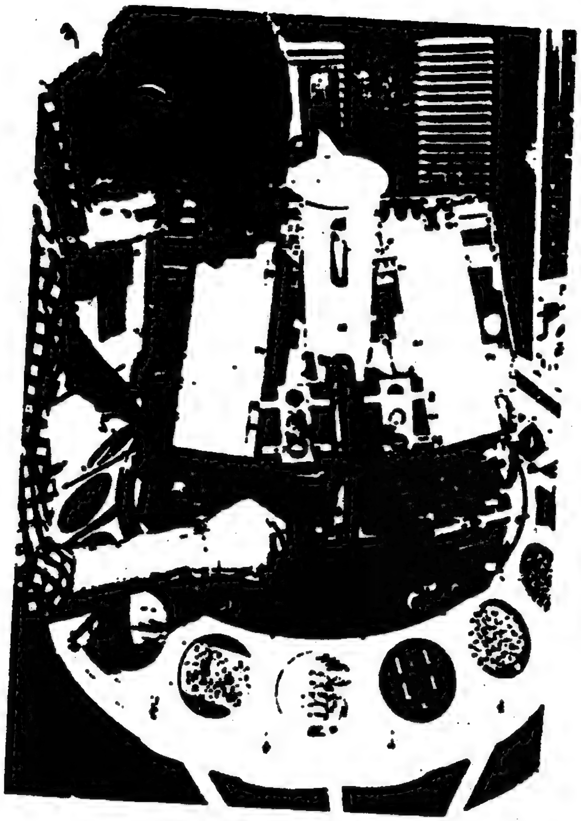
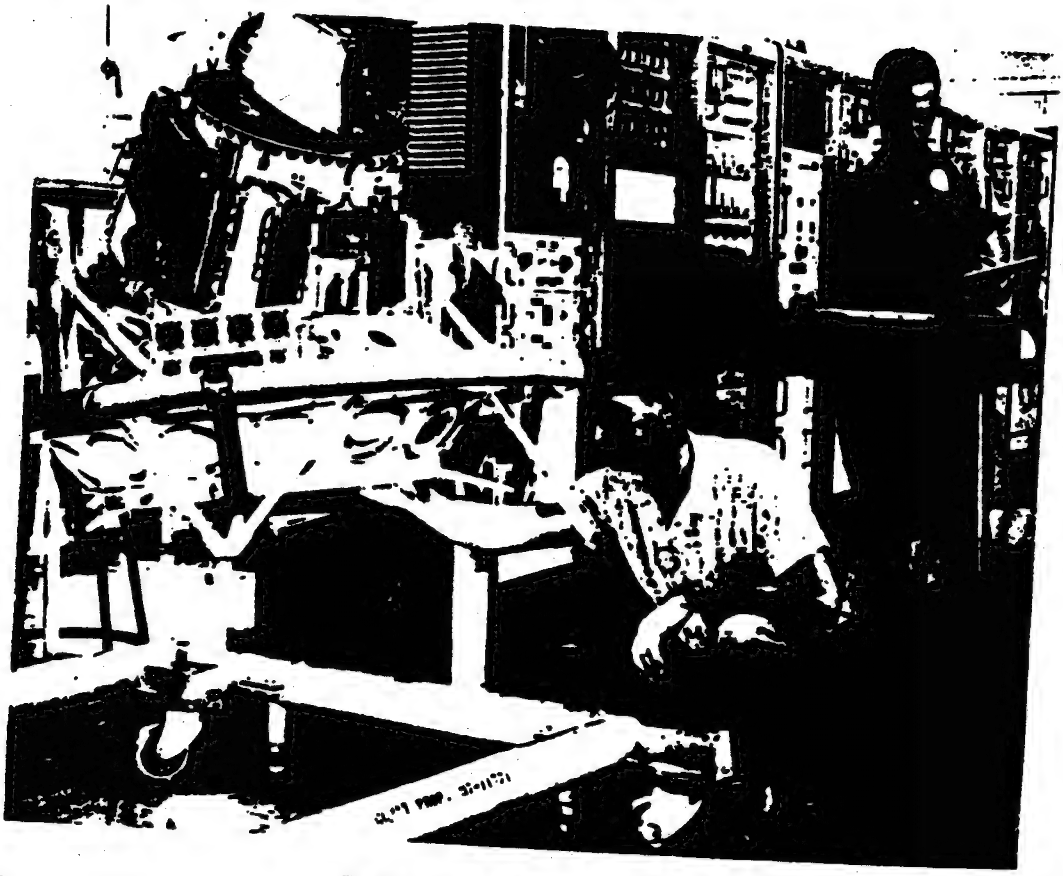


Figure 7. The Baird Atomic, Inc., infrared detector payload during checkout at the Lockheed Sunnyvale facility. This payload will be carried on the third MIDAS flight which is currently scheduled for February 1961. The payload checkout equipment is contained in the equipment racks shown on the background.



October. This equipment will be installed in the Satellite Test Center; a second unit will be installed in the Vandenberg Air Force Base Tracking station. The late delivery of the equipment for the Satellite Test Center will not affect the scheduled activation date. Some revision of the integration activity will be required; however, this will not affect the MIDAS launch schedule. Delays in delivering the second unit of ground station equipment, however, will cause some slippage in the Vandenberg Air Force Base tracking station activation date for support of MIDAS flights.

Facilities

- A detailed evaluation of launch pad requirements for the MIDAS operational phase has been accomplished. This study indicates the need for a three-pad launch complex during the establishment of the operational network, and a requirement for from two-to-three pads for maintaining the MIDAS satellite network once the buildup phase has been completed.

- Final acceptance of North Pacific station technical facilities at Donnelly Flats, Alaska, was accomplished on 29 September. The heated vehicle storage building at Fort Greely is scheduled for completion on 31 October. Completion of the combined dormitory and dining hall facility, except for exterior area grading, will be completed on 30 December. The Donnelly Dome microwave relay station is scheduled for completion on 15 December. Beneficial occupancy of the remaining North Pacific communications stations is programmed for 1 January 1961.

- Third Air Force has received authorization to proceed with design of the United Kingdom station. Design criteria now being prepared by AFBMD and associate contractors is scheduled for completion in late October. Negotiation of government-to-government and technical agreements is scheduled to start early in November.

- Design of support facilities for the Southeast Africa station is currently underway by an Air Force Missile Test Center/Pan American Airways, Inc., team. Construction of facilities is scheduled for completion on 17 December with a stational operational date of 31 January 1961. The government-to-government agreement for this station is still pending.

- All New Boston station support facilities located on Grenier Field, New Hampshire, were completed and accepted during the report period. Support facilities on the New Boston station are on schedule. Design of the data acquisition and processing building modification has been completed and a construction contract is presently being negotiated. Completion is scheduled on an incremental basis with final completion scheduled for 1 January 1961.

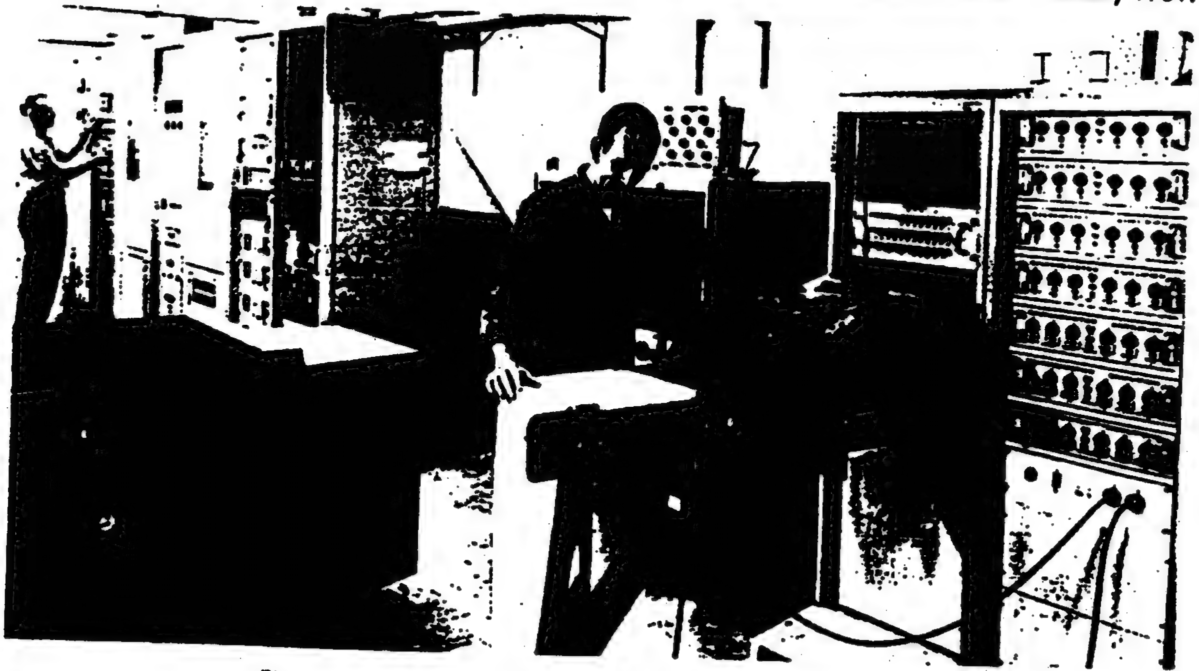


Figure 8. Overall view of the MIDAS ground equipment currently installed in the Satellite Test Center. The drawer pulled out houses the oscillographic equipment. The equipment racks in the rear house the tape recorder installation.

[redacted]

TABLE 7: SECOND GENERATION AREA SURVEILLANCE SATELLITE DATA

NAME	LAUNCH DATE	LAUNCH VEHICLE	LIFE (DAYS)	INCL. (DEG.)	PERIOD (MIN.)	PERIGEE-APOGEE (MILES)
none	28 Feb 1963	TAT-Agena D		failed to orbit		
none	18 Mar 1963	TAT-Agena D 1164		failed to orbit		
1963-16	18 May 1963	TAT-Agena D	8	74.54	91.12	96-113
1963-19	13 Jun 1963	TAT-Agena D	29.1	81.87	90.67	120-262
1963-25 ✓	27 Jun 1963	TAT-Agena D 1166	29.7	81.6	90.5	123-248
1963-32	31 Jul 1963	TAT-Agena D	12	74.95	90.4	98-257
1963-34	25 Aug 1963	TAT-Agena D 1001	18.6	75.01	89.4	101-200
1963-37	23 Sep 1963	TAT-Agena D 1002	18.2	74.90	90.63	101-276
1963-42 ✓	29 Oct 1963	TAT-Agena D 1601	83.51	89.90	90.84	174-215
1963-55 ✓	21 Dec 1963	TAT-Agena D 1162	18	64.94	89.96	110-222
1964-08	15 Feb 1964	TAT-Agena D	[redacted]	74.95	90.86	112-278
none	24 Mar 1964	TAT-Agena D 1003	failed to orbit			111-279
1964-22	27 Apr 1964	TAT-Agena D 1005	28.19	79.93	90.77	93-268
1964-27	4 Jun 1964	TAT-Agena D 1006	13.94	79.96	90.27	110-289
1964-32	19 Jun 1964	TAT-Agena D 7	26.81	85.0	90.95	113-288
1964-37	10 Jul 1964	TAT-Agena D 8	26.52	84.98	91.00	114-273
1964-43	5 Aug 1964	TAT-Agena D 9	26	79.96	90.71	108-291
1964-56	14 Sep 1964	TAT-Agena D 10	21.7	84.96	90.88	114-275
1964-61	5 Oct 1964	TAT-Agena D 11	20.5	79.97	90.75	118-260
1964-67	17 Oct 1964	TAT-Agena D 12	17.27	74.99	90.59	113-280
1964-71	2 Nov 1964	TAT-Agena D 13	25.33	79.95	90.7	113-212
1964-75	18 Nov 1964	TAT-Agena D 14	17.45	70.02	89.71	114-256
1964-85	19 Dec 1964	TAT-Agena D 1015	26.06	74.97	90.46	149-165
1964-87	21 Dec 1964	TAT-Agena D	21.64	70.08	89.5	113-263
1965-02	15 Jan 1965	TAT-Agena D	25.0	74.95	90.52	111-236
1965-13	25 Feb 1965	TAT-Agena D	20.92	20.92	75.08	116-166
1965-26	25 Mar 1965	TAT-Agena D	10.1	10.1	96.08	110-296
1965-33	29 Apr 1965	TAT-Agena D	26.5	26.5	85.04	124-207

[redacted]

[redacted]

[redacted]

TABLE 7: SECOND GENERATION AREA SURVEILLANCE SATELLITE DATA

(Continued)

NAME	LAUNCH DATE	LAUNCH VEHICLE	LIFE (DAYS)	INCL. (DEG.)	PERIOD (MIN.)	PERIGEE-APOGEE (MILES)
1965-37	18 May 1965	TAT-Agena D	28.24	28.24	75.01	110-227
1965-45	9 Jun 1965	TAT-Agena D	12.58	12.58	75.07	114-290
1965-57	19 Jul 1965	TAT-Agena D	29.25	29.25	85.05	113-254
1965-67	17 Aug 1965	TAT-Agena D	54.40	54.40	70.04	113-254
none	2 Sep 1965	TAT-Agena D		failed to orbit		
1965-74	22 Sep 1965	TAT-Agena D	18	80.01	90.04	119-228
1965-79	5 Oct 1965	TAT-Agena D	24.01	75.05	89.75	127-202
1965-86	28 Oct 1965	TAT-Agena D	19.81	74.97	90.54	110-269
1965-102	9 Dec 1965	TAT-Agena D	16.78	80.04	90.72	114-273
1965-110	24 Dec 1965	TAT-Agena D	26.59	80.01	90.83	111-279
1966-07	2 Feb 1966	TAT-Agena D	24.67	75.05	90.64	116-266
[redacted] 1966-18 1622	[redacted] 9 Mar 1966	TAT-Agena D	19.83	75.03	90.59	111-270
1966-29 162 1014	[redacted] 7 Apr 1966	TAT-Agena D	18.43	75.06	89.56	121-195
none	3 May 1966	TAT-Agena D		failed to orbit		
1966-42 1639	[redacted] 24 May 1966	TAT-Agena D	16	66.04	89.00	112-169
1966-55 1626	21 Jun 1966	TAT-Agena D	22	80.10	90.15	121-229
1966-85 1623	[redacted] 20 Sep 1966	TAT-Agena D	21.90	85.13	90.87	118-276
1966-102 1632	8 Nov 1966	TAT-Agena D	20.6	100.09	89.42	108-199
1014	21 Dec 1966	TAT-Agena D	[redacted]	[redacted]		
1967-02 1619	14 Jan 1967	TAT-Agena D	18.7	80.07	90.13	113-238
1967-15 1635	[redacted] 22 Feb 1967	TAT-Agena D	17.02	80.03	90.12	113-238
[redacted] 1967-29 1636	[redacted] 30 Mar 1967	TAT-Agena D	17.65	85.03	89.45	104-204

[redacted]

[redacted]

[redacted]

[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

[redacted]

[redacted]

[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

[redacted]

[redacted]

[redacted]

TABLE 9: DATA ON THIRD GENERATION AREA SURVEILLANCE LAUNCHES

NAME	LAUNCH DATE	LAUNCH VEHICLE Thorad = LTTAT	LIFE (DAYS)	INCL. (DEG.)	PERIOD (MIN.)	PERIGEE-APOGEE (MILES)	
1966-72 1631	9 Aug 1966	LTTAT-Agena D	32.20	100.12	84.35	121-179	
P-846 1967-43 B ✓	9 May 1967	LTTAT-Agena D 1634	64.62	85.10	94.36	125-485	[redacted]
P-846 1967-62 B ✓	16 Jun 1967	LTTAT-Agena D	33.16	80.02	89.97	113-229	[redacted]
1967-76	7 Aug 1967	LTTAT-Agena D	24.85	79.94	89.72	109-216	[redacted]
1101 (C53) 1967-87	15 Sep 1967	LTTAT-Agena D	18.69	80.07	89.95	94-243	
P-846 1967-109 B	2 Nov 1967	LTTAT-Agena D 1639	29.83	81.53	90.47	114-256	[redacted]
1967-102	9 Dec 1967	LTTAT-Agena D	15	81.65	88.45	99-148	[redacted]
P-846 1968-08 B ✓	24 Jan 1968	LTTAT-Agena D 1638	33.54	81.48	90.55	110-269	[redacted]
P-846 1968-20	14 Mar 1968	LTTAT-Agena D 1640	26.22	83.01	90.20	111-244	[redacted]
1968-39	1 May 1968	LTTAT-Agena D	14	83.05	88.58	103-152	[redacted]
P-846 1968-52 B ✓	20 Jun 1968	LTTAT-Agena D 1643	25	84.99	89.75	121-204	[redacted]
1968-65	7 Aug 1968	LTTAT-Agena D	19.45	82.11	88.60	95-161	[redacted]
P-846 1968-78 B ✓	18 Sep 1968	LTTAT-Agena D 1645	19.25	83.02	90.12	106-246	[redacted]
1968-98	3 Nov 1968	LTTAT-Agena D	19.99	82.15	88.90	94-180	
1049 1968-112 A	12 Dec 1968	LTTAT-Agena D	15.65	81.02	88.67	106-155	1014
1106 P-162 1969-10 A	5 Feb 1969	LTTAT-Agena D	18.80	81.54	88.70	111-149	[redacted]
1050 P-846 1969-26 B ✓	19 Mar 1969	LTTAT-Agena D 1649	4.35	83.04	88.73	112-151	[redacted]
1051 P-846 1969-41 B ✓	2 May 1969	LTTAT-Agena D 1651	21.35	64.97	89.54	112-204	[redacted]
1969-63	24 Jul 1969	LTTAT-Agena D	30.44	74.98	88.49	111-138	[redacted]
P-846 1969-79 B ✓	22 Sep 1969	LTTAT-Agena D 1652	19.74	85.03	88.83	111-158	[redacted]
P-162 1969-105	4 Dec 1969	LTTAT-Agena D	36.26	81.48	88.61	98-157	
P-846 1970-16 B ✓	4 Mar 1970	LTTAT-Agena D 1656	21.98	88.02	88.76	104-161	[redacted]
P-846 1970-40 B ✓	20 May 1970	LTTAT-Agena D 1657	27.53	83.00	88.62	101-154	[redacted]
1970-54	23 Jul 1970	LTTAT-Agena D	26.99	60.00	90.04	99-249	[redacted]
P-846 1970-98 B ✓	18 Nov 1970	LTTAT-Agena D 1659	22.78	82.99	88.70	116-145	[redacted]
none	17 Feb 1971	LTTAT-Agena D		failed	to orbit		
1971-22	24 Mar 1971	LTTAT-Agena D	18.81	81.52	88.56	98-154	
P-846 1971-76	10 Sep 1971	LTTAT-Agena D	25.02	74.95	88.48	98-153	[redacted]
1972-32	10 Apr 1972	LTTAT-Agena D	22.77	81.48	88.85	97-173	[redacted]
1117 P-162 1972-39	25 May 1972	LTTAT-Agena D	10.20	96.34	89.17	99-191	